THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

Vol. XXI December, 1927 No. 6

Annual Dinner To Be Held Jan. 12

Will Be at Hotel Astor—Annual Meeting Will Be at the Book-Cadillac, Detroit, Jan. 24 to 27

Thursday of the week of the New York Automobile Show will again see the S.A.E. Annual Dinner at the grand ballroom of the Hotel Astor. Interesting plans, which promise to make the 1928 Annual Dinner a memorable event, are being worked out by F. K. Glynn, chairman of the Annual Dinner Committee. Members who have enjoyed hearing Maurice Garabrant at the organ at previous dinners will be glad to know that he will play at the forthcoming dinner. Scotty Brazil, well known to S.A.E. members for his inimitable way of leading the "community" singing, will be back again after an absence of 2 years.

The Annual Business Session will convene during the Annual Dinner. It will last long enough for the results of the election of officers to be announced. The business session will then adjourn until the evening of Tuesday, Jan. 24, when it will re-convene at the Book-Cadillac, Detroit, on the opening evening of the Annual Meeting.

Further details regarding the Annual Dinner will be found in the next *Meetings Bulletin*, which will be mailed about the middle of this month. The dinner application blanks will be enclosed with it and members are urged to make their reservations early.

The Annual Automobile Show Dinner, which is the annual "open house" of the Metropolitan Section, will be held Monday evening at the Commodore Hotel. As in former years, the National Automobile Chamber of Commerce Dinner will be on Tuesday, Jan. 10, at the Commodore Hotel, and the Motor and Accessory Manufacturers' Association Dinner will be on Wednesday, Jan. 11, at the Hotel Astor.

Plans for the Annual Meeting

The second week following the New York Automobile Show, which is the week preceding the Chicago Automobile Show, has been decided upon for the time of the Annual Meeting of the Society, which will be held this year at the Book-Cadillac instead of at the General Motors Building, where the Annual Meetings have been held since 1923. The meeting will occupy the 4 days from Jan. 24 to 27, inclusive. Morning, afternoon and evening sessions are to be held each day. The technical program arranged by the Meetings Committee is most comprehensive, more than 25 papers having been scheduled on subjects of outstanding interest at this time.

Papers submitted at the sessions will not be read in full; instead, each author is to summarize his paper in a 15-min. period. Copies of the papers will be available before the meeting and at the sessions, thus making the reading of the complete papers unnecessary and making available more time for general discussion.

Among the subjects to be discussed are high-speed versus low-speed engines, supercharging, multiple ignition, dual carbureters, high-compression engines, aluminum pistons, shock-absorbers, brakes, front-wheel drive, European chassis developments, Diesel engines, detonation, oils, high-speed motion-pictures, headlighting, cast iron, chromium-plating, and testing of lacquers and fabrics.

As stated in Chronicle and Comment in this issue, no carnival will be held this year in connection with the Annual Meeting.

An innovation at the Annual Business Session, on Tuesday evening, will be the election of three members-at-large to serve on the Society's Annual Nominating Committee. Hitherto this election has been held at the Semi-Annual Business Meeting, but the recently adopted amendment to the Constitution provides that these three members shall be elected at the Business Session of the Annual Meeting preceding the Annual Meeting at which officers are to be elected. Electing the Nominating Committee 6 months earlier than has previously been the case gives the Committee more time in which to investigate and consider the qualifications of members eligible for office in the Society. Prior to the Annual Meeting, one member will be chosen from and by each Section of the Society to serve on the Annual Nominating Committee. No two of the three members-at-large may reside in the same Section territory.

Following the election of the three members-at-large, the Nominating Committee will hold its organization meeting at some convenient time during the Annual Meeting.

Summer Meeting To Be in Quebec

On Oct. 18 a special issue of the *Meetings Bulletin* was sent to the members outlining four possibilities for the 1928 Summer Meeting: Quebec, Spring Lake, Atlantic City and a cruise to Nassau. Postal-card ballots were enclosed, with the request that the members indicate their preference of the places proposed. No Western places were considered, as it had been decided that the 1928 Summer Meeting should be held in the East, the 1926 and the 1927 Summer Meetings having been held at French Lick Springs.

The ballot resulted in Quebec and the ocean cruise receiving practically the same number of votes; Atlantic City and Spring Lake followed several hundred votes behind in third and fourth places respectively.

At the request of the Meetings Committee, the members voting for Spring Lake and Atlantic City reported their preference as to Quebec or the cruise and, as a result of the additional votes, Quebec received a decided majority. The Meetings Committee consequently recommended holding the 1928 Summer Meeting at the Chateau Frontenac, Quebec, and this recommendation was approved by the Council at the Nov. 21 meeting. The dates for the 1928 Summer Meeting will be announced in the January issue of THE JOURNAL.

Meetings Calendar

Annual Dinner
Jan. 12, 1928
Hotel Astor, New York City

Annual Meeting
Jan. 24 to 27, 1928
Book-Cadillac, Detroit

Sections Calendar

Buffalo Section Meeting—Dec. 6, 1927
Gas Engine Lubrication—H. L. Newton

Chicago Section Meeting—Dec. 13, 1927
New Advances in the Study of Engineering Materials by Means of X-Rays—Prof. G. L. Clark

Cleveland Section Meeting—Dec. 19, 1927
Research—Dr. H. C. Dickinson

Dayton Section Meeting—Dec. 5, 1927
How To Sell Automobiles—R. H. Grant

Detroit Section Meeting—Dec. 5, 1927
Four-Wheel Brakes—John R. Cautley, Paul D. Harvey, R. M. Heinrichs, Frank C. Pearson, and W. R. Strickland

Indiana Section Meeting—Dec. 15, 1927
The Automobile of the Future—T. A. Boyd

Metropolitan Section Meeting—Dec. 15, 1927
Engines—W. S. James

Milwaukee Section Meeting—Dec. 7, 1927
Papers on Automotive Research, by W. S. James, and Valve Spring Surge, by W. T. Donkin

New England Section Meeting—Dec. 7, 1927
Papers on Lubrication, by George A. Round, and Fuels, by Prof. W. H. McAdams

Northern California Section Meeting—Dec. 8, 1927
Six-Wheelers and Six-Wheel Attachments

Pennsylvania Section Meeting—Dec. 13, 1927
Effect of Vehicle Design Changes on Service-Station Equipment—W. W. Shelling

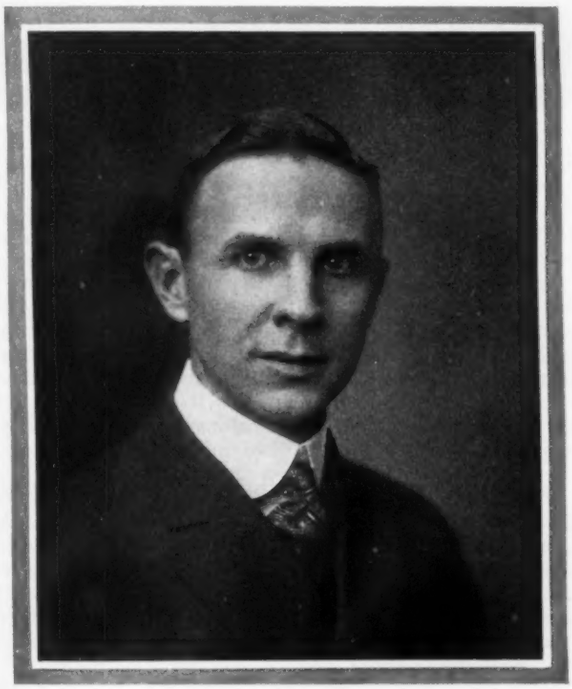
Southern California Section Meeting—Dec. 2, 1927
Papers on Front-Axle Alignment, Shimmying, Effects of Balloon Tires, and Causes of Front-Axle Misalignment, by A. H. Hamilton, F. W. Stavely and J. E. Van Sant

Washington Section Meeting—Dec. 2, 1927
The Twin Coach—Frank R. Fageol

Detroit Stages Record Meeting

Schlee Carries 700 Detroiters Around the World and Stout Shows Them Aviation in America

Aviation Day with the Detroit Section was Nov. 7, beginning in the afternoon at the Ford Airport in Dearborn, where 200 of the members were given airplane rides in Stout all-metal airplanes. The Section dinner was held at the Book-Cadillac, with 540 members and guests, men and women, seated at the tables; and the number grew to 700 who attended the meeting after the dinner. They came from Pontiac, Flint, Lansing, and Toledo, as well as from nearer suburbs of Detroit. In expressing his gratification at the large attendance, Chairman Walter T. Fishleigh gave all the credit to the eight other officers and congratulated the



CHAIRMAN WALTER T. FISHLEIGH

Section on having officers who are so willing to do the work necessary to carry out any plans that are made.

When called upon for remarks, John H. Hunt, President of the Society, reiterated the willingness of the Society to do everything in its power to cooperate with aviation engineers. He said that during the first stage of aviation, following the demonstration by the Wright brothers of the possibility of actual flight, a lot of adventurous young men carried on at great risk to themselves. The second period was the hectic development during the War, which left the market flooded with equipment not well suited for the demands of peace. With the recovery from this condition came the third period, of peace-time development, the fruits of which we are now beginning to gather.

Brief remarks also were made by L. M. Woolson, the last chairman of the Section, who is prominent in aeronautic development at the Packard Motor Car Co., and by William Chamberlain, a one-armed aviator who has been flying for about 12 years and is now piloting an airplane for the Tide Water Oil Co.

In introducing Edward F. Schlee, the first scheduled speaker, Chairman Fishleigh praised him and William S. Brock as showing the greatest nerve of all when they decided to let well enough alone after making their wonderful flight from America to Japan.

PLANNING AN AROUND-THE-WORLD FLIGHT

Mr. Schlee told the story of the record-making flight of the Spirit of Detroit, starting with June 16, when the first plans were laid. The first step was the preparation of an airplane in 5 days for the Ford Air Tour. After that tour the engine was changed and the plane was very carefully prepared for its long world tour. The trip was planned with a regular schedule on the same basis as the National Air Tour; but, instead of flying 2 or 3 hr., their schedule called for 7 to 10 hr. per day.

The start was delayed a little to obtain aluminum cans for gasoline to avoid the influence of tin cans on their instruments. Learning from the Weather Bureau that there are only 12 flying days in the course of the year at Newfoundland, the fliers arranged to have a landing-field, or at least a runway, prepared at Harbor Grace in 15 days.

In flying across the Atlantic they overestimated the effect of the strong tail-wind and thought they were above France when they reached England. Then was the first time they found their location by flying low and reading the names on railroad stations. They did this again in Germany near

EDWARD F. SCHLEE

Stuttgart, and in the Balkans, but they found the names rather hard to read.

One of the greatest difficulties was securing maps and directions for flying over Eastern Europe and Asia, although officers and Government representatives were ready to assist in every way possible. From Constantinople to Bagdad they were obliged to follow the railroad.

Because of the mountainous country it was not planned to fly at night, but darkness came before they reached Bagdad, while flying from Constantinople, and they made a

DETROIT SECTION HIGH-HAT ORCHESTRA

The Highest Paid Orchestra in the World, and Also the Worst, According to the *Detroit Super Charger*. Left to Right: H. Albert Hansen, C. Newman Dawe, Edward W. Griffith, Fred A. Cornell, D. E. Anderson, Edward V. Rippingille, Phil N. Overman

hazardous landing on a flying-field that was located by the red lights of the conning towers.

There was trouble with poor visibility while going over some of the mountainous regions and at one time they had to rise to at least 6000-ft. altitude to avoid the worst of a sandstorm. Sometimes they started out with a small load of gasoline to enable them to rise over the Alps and other high mountains.

The only engine trouble they had was encountered in Asia, where the valve push-rods had become rusty and a new spark-plug was required.

In flying from Hanoi, in French Indo-China, to Hongkong they encountered a heavy head wind, so they landed with less than 10 gal. of gasoline in the tank and with the engine missing, because of magneto trouble.

For the flight to Shanghai they required 250 gal. of gasoline and had difficulty in rising from the short runway. Reaching Shanghai, they realized that the race course where they had planned to land would not be big enough for taking off, so they landed at the Chinese airdrome, and the American Consul made their peace for landing without a permit.

An extra landing was made in Japan because the fliers were lost in a storm, and they finally landed in Tokio 15 min. ahead of a typhoon that took the roof off the railroad station and destroyed communication lines, so the news of their landing was sent to the press by pigeons.

"BILL" STOUT ON THE AIR

In beginning his talk, Mr. Stout said that people look upon an airplane with suspicion because, like a hobo, it has no visible means of support; but if anyone who is traveling through the air at high speed will put out his hand he will realize that the support is just as sure as the water in the ocean.

The world has changed more in its basis of facts in the span of our lives than in the whole previous history of the world, he said. It changes more now in one year than it did during the whole lifetime of our fathers, so we have to be alert to keep up.

One of the first means of completely revolutionizing society was the automobile. Throughout history theretofore, everything revolved around the speed of the horse as the basis of transportation. The automobile increased the social radius from 15 to 150 miles. Americans are more alert than other people because driving a motor-car forces alertness.

The automobile industry has taken a man of such a low order of intelligence that he could support his family only in squalor and has given him a job on the assembly line. Even though he has not intelligence enough to tighten one nut properly without a special wrench to guard against stripping the threads, he is now able to earn enough to give his family a separate house with a garden, an automobile and the best of education for his children. He lives in greater luxury than the millionaire of a generation ago. Thus the automobile has become a mechanical missionary.

COMMUNICATION ADVANCED WITH TRANSPORTATION

Each method of transportation is linked with a mode of communication. With the railroads came the telegraph; the telephone is associated with the automobile; and the radio is linked with the airplane. According to Mr. Stout, flying without the radio will soon be thought as impossible as running a railroad without a telegraph or a telephone system.

The radio is another great missionary in bringing people closer together. We have been trying to bind the nations together, and the microphone is the foundation of an international language. The only international language now is music, but soon there will be an international language of words and they will be words of the language used in the best radio programs. The airplane provides one of the best means of bringing peoples together. It will shrink the world to one-quarter of its present size and make the understanding between nations four times as good as now.

In the older cities it was necessary to build houses close together so men could live within walking distance of their work; men were obliged to work near where they lived. With an automobile a workman can now live farther from his place of work and is more independent to improve himself. Detroit is better than many Eastern cities because much of it has been built since the automobile came.

To show the present safety of flying, Mr. Stout said that the Ford airlines have been operating between Detroit and Buffalo and between Detroit and Cleveland for 2½ years, and for a year between Detroit and Grand Rapids. The airplanes from the Ford Airport are flying 2000 miles per day, and they have not had a single forced landing outside the fields because of mechanical trouble.

Air-mail lines fly 3000 miles each night, and there are a number of other airlines operating on daily schedules

throughout the Country. These airlines, flying 27,000 miles per day, do not cost as much in human life as do the automobiles in a single city block. The most dangerous periods connected with an airplane flight are said to be the taxicab rides to and from the air-fields.

Air Travel Exemplified

At the time Colonel Lindbergh came back from France, Mr. and Mrs. Stout had lunch in Dearborn, Mich., at 12:30 and ate their dinner in the Mayflower Hotel in the City of Washington at 6 o'clock the same day, spending part of the intervening time asleep in the three-engine airplane that carried them.

After spending 2 or 3 days in witnessing the welcomes to Colonel Lindbergh in the City of Washington and New York City, Mr. Stout gave a talk in Schenectady where a bond issue for an airport was under discussion. The following morning the party had breakfast at 6 o'clock in Schenectady and flew back to Dearborn in time for lunch at 12:30.

On the occasion of another trip to the City of Washington, Mr. Stout had a radio on his airplane and talked with some of the Government officials from the air just as freely as though speaking from another office. This equipment will be of great assistance to an aviator in securing information on the weather and other conditions ahead of him.

In concluding, Mr. Stout said that there is an erroneous impression that Europe is far ahead of us in aviation. On the contrary, Americans fly more miles per day than all the airplane lines in Europe combined and America is the only country that has developed the technique of night flying. He said that Detroit should be the aviation center.

At the close of Mr. Stout's talk the room was cleared for dancing to music furnished by an orchestra that is guaranteed to be the highest salaried orchestra in the world that is playing dance music. It is the Detroit High Hat Orchestra, composed of members of the Section. After they began to play, there was a unanimous conviction that these seven men are the best automotive engineers in Detroit.

Man-Training for the Industry

State and City Educators Tell Southern California Section of Vocational Work

Four scheduled speakers and several other educators presented a symposium on Training Men for the Automotive Industry at the Nov. 4 meeting of the Southern California Section. The meeting was one of the most successful ever held by the Section, according to Chairman Ethelbert Favary, who reported that 107 reservations were made for the dinner at 6:15 p. m. at the City Club in Los Angeles, and that 25 other members and guests came in afterward to attend the technical session.

The meeting elected Fred C. Patton, assistant manager of the Los Angeles Motor Bus Co., to represent the Section on the Society's Sections Committee for 1928.

Announcement was made that the next meeting of the Section will be held Dec. 2, and will be a joint meeting with the Service Managers Association and the Automotive Council. The subject of the evening will be Front-Wheel Alignment—Effects of Front Springs, Balloon Tires and Other Causes of Misalignment.

The four scheduled speakers were John C. Beswick, chief of the bureau of trade and industrial education of the State of California; Benjamin W. Johnson, assistant director of the division of vocational education, University of California; W. S. Kienholz, director of vocational education, Los Angeles City schools; and H. A. Campion, principal, Frank Wiggins Trade School, Los Angeles. In addition to these, Dr. Ernest C. Moore, director of the University of California at Los Angeles; Mrs. Elizabeth Clark, of the Los Angeles Board of Education; and R. W. Stewart, chief deputy city engineer of Los Angeles, also spoke.

Work Aided by Nation and State

Speaking of the work of the bureau of trade and industrial education of the State Department of Education, Mr. Beswick dealt first with the necessity of vocational education as an economic asset to the State and Nation, then outlined the State plan of work for the promotion of vocational education and gave a few examples of the work and its progress in the State of California.

The State now has a commission that deals with the problem of vocational education through Federal and State-aided classes supported in part by more than $500,000 in Federal and State funds, each Federal dollar being matched by a State dollar. The work supported by these funds is confined to two lines: trade and industrial education, and rehabilitation for workers injured in industry. A man injured in an industry may call for someone from the State Department of Education to discuss with him the possibilities of receiving training that will fit him to take up some other line of work. If he has lost a hand, for example, the State representative will talk with the manager of the plant in which he was injured and arrange for a training program that will enable the man to go back into the plant on some other job. In every case in which the State has rehabilitated such an individual, he has gone back into another job at more pay than he received before the accident.

Another program that is being set up is that of training individuals on a pre-employment basis through what is known as the all-day school in the high school. Where the school day is 6 hr. long, 3 hr. are devoted to practical work on a commercial basis, 1½ hr. to trade and related technical instruction, and 1½ hr. to academic work. All instructors are practical craftsmen. This all-day school is the least efficient program of trade and industrial education, said Mr. Beswick, for statistics show that only about one-half of the boys go into the trade for which they study.

Cooperative Training in Automotive Industry

The State is more interested, however, in the cooperative part-time training in which the student spends half of his time in industry, usually in one-week periods, and the other half of his time alternately in school. Some of these part-time classes are in operation in connection with the automotive trade. In Oakland, for example, 32 boys who have completed part of their training in the all-day school are working on a cooperative part-time basis in garages. A competent automotive man goes into the plant where the boys are working to instruct them on the job and to discuss with the foreman what additional training each boy should have during the week he is in school.

Another important phase of the educational program is the trade-extension work for improving the status of men already employed in the automotive industry, through either day or evening classes.

Last year the City of Los Angeles received about $77,000 of Federal money for the promotion of vocational education, according to Mr. Beswick.

The automotive industry is confronted by two problems, said the speaker; first, an apprentice program for the repair-man, and second, an apprentice-training program for workers in plants that manufacture automobiles, trucks, or tractors. When an organized apprentice-training program was started in the plant of the Caterpillar Tractor Co. at San Leandro, for the purpose of training boys in the machinist trade, 200 boys applied, although only 24 were

wanted. The company erected a building on the plant grounds, equipped it with necessary machinery for giving proper instruction, and equipped a good technical library with drawing tables and instruments so that instruction can be given efficiently. As a result of the instruction received, the boys have been able to triple production on some machine operations.

Another example of a part-time program is that of the Axelson Machine Co.'s plant, where an advisory committee was set up to work out a program. Seventy-five boys applied to enter the apprenticeship work, and 20 were selected at the start. A steel building was constructed on the grounds and the Board of Education equipped it with desks and necessary apparatus for giving instruction on the job. The plant manager desired to train all-round machinists and to pick from the group outstanding machinists for the tool-making department. He was not interested in training operators, but students showing ability in salesmanship would be indentured for 2 years more and then be sent into different oil fields of the world to represent the company. The idea was that the boys who came up through the organization of the plant should have an opportunity to learn all of the technical phases and manufacturing processes in the plant, so that when in some foreign field they would be qualified to make recommendations of an engineering nature if there was need of redesigning a pump to meet conditions in a particular field. The company also offered to assist in financing one or more students, who showed special ability and capacity, to take an engineering course at a university.

Several years ago, only 7000 students were enrolled in the evening schools, but now more than 140,000 are enrolled, said the speaker. The State Department of Education stands ready to assist an association, an individual plant or a garage, in organizing vocational work, and has money to reimburse local boards of education for the industry.

A system of tests for trade training, as conducted by the division of vocational education at the University of California in Los Angeles, was outlined by Mr. Johnson. The purpose of the oral and written examinations is to determine the man's technical and workmanship ability, and to attempt to determine the motive forces and personality that may make his journeyman ability effective.

Trade Extension-Courses Becoming Important

The training in apprenticeship is becoming a more prominent feature of the educational organization of the Frank Wiggins Trade School in Los Angeles, according to Mr. Kienholz, who said that it is not the old form of apprenticeship training. Trade extension-work provides training for people already engaged in industry, who have made a choice of occupation and are anxious to improve themselves by evening or day-time study. The aim is to enlist the support and help of industry all the way through the program. There are forms of vocational training in practically all of the 52 high schools in Los Angeles, he said, and possibly 6500 students are doing some kind of vocational work. The instructors are carefully selected and the University of California is giving a splendid course of teacher training.

The great need in the automotive trade is for all-round skilled mechanics, and a big present problem is to train the mechanics in a company's own plant instead of hiring or stealing them from other plants, which is beginning to be recognized as poor policy, asserted Mr. Kienholz. If possible, foremen should be selected from among men who have grown up through a company's own organization. Training one's own workmen results in greater flexibility in a time of heavy production or of serious competition, as such men can be shifted from one job to another without friction or loss of time. It also results in greater loyalty of the employes and in less labor turnover. Accidents also are greatly reduced when men are trained in the company's own plant.

The schools work with industrial plants in training these people on a cooperative or apprenticeship basis. Twenty different high schools in Los Angeles are excellently equipped to do automotive work, with splendid men in charge and excellent students in the classes. These schools desire to make closer contact with the automotive industry and to obtain good instructors from the industry.

Principal Campion stated that the Frank Wiggins Trade School is a new $1,000,000 institution, recently erected by the Board of Education of Los Angeles. The building has 11 floors and 31 different trades are taught, from bricklaying to beauty culture. The greatest of all the courses is automotive instruction, with the most floor space, the largest investment in equipment and a high-caliber faculty.

Should Start Automotive Engineering Schools

Director Moore, of the University of California, said that he liked to think of vocational education as training men for relationship to their fellow-men, and for providing their living and helping the world onward. He said he wanted to find out what an automotive engineer is and whether the colleges have any duty toward the automotive engineer. Colleges and universities throughout the United States are establishing departments of aeronautics, which are really departments of automotive mechanics, and it seemed to him there is no good reason why they should have professors of aeronautics and not professors of mechanics. The University of California at Los Angeles has maintained for 8 years a department of automotive mechanics in which it has trained a great number of soldiers to assist in this difficult part of the work of the Army, has re-educated a number of wounded and maimed soldiers, and has a basis of experience, machinery and skill that can readily be formed into a school of automobile engineering if it is demonstrated to the citizens of California that their tax money should be used for this purpose.

We must think of young people in terms of life, said Mrs. Clark, and as the whole is greater than any of its parts, we must think of them in relation to their health development and character building as well as their vocational adjustment; but health and character are established merely that individuals may function as citizens. To this end, young people in the junior high school must have something of vocational knowledge, for not all of them go on to high school; therefore the junior high school has its vocational exposure classes all the way through, which will assist the students in finding out what they desire to do.

Deputy City Engineer Stewart stated that the engineering department of the City of Los Angeles owns and operates 117 trucks, and its problem is to secure, not only mechanics, but also drivers. Many men who apply for jobs as drivers do not like to do hard work but can steer an automobile, and they expect to earn a living thereby and spend a great deal of time in a pool hall. He said it struck him that the city truck department would be a good place for a man to come from the trade schools to get employment, and if those interested in promoting the welfare of the graduates of the trade schools want to cooperate with the city service department, arrangements can be made so that a higher grade of young man will be employed by the city for the operation of its motor-trucks.

Students Taught Related Subjects

In the discussion, Joseph Scott, of the Bureau of Power and Light, inquired whether the vocational training is all along mechanical lines or if an attempt is made to teach work costs and the reasons for the cost. To this Mr. Kienholz replied that there is carried on, in conjunction with the mechanical training, related subject work such as the science and mathematics of the trade, drawing and blueprint work, and other supplemental subjects which it is thought will make the worker more efficient and in which the aim is to inform the student as to the why of the job.

William H. Fairbanks, of the Southern California Telephone Co., said that the remarks of one speaker on the theme of aptitude and loyalty impressed him strongly. If a man does not have aptitude, there is not much use in training him, and if he does not have loyalty, no one wants him. It is the practice of his company, he said, whenever a first-class mechanic is wanted, to get an aviation mechanic trained by the Army or Navy, and his work is as near perfection

as possible. This carries out the thought that so many mechanics are inclined to be slipshod. Operators of fleets want men who will turn out work of exactness and of a quality performed by the apprentice-trained mechanic in Europe.

If there is one thing that is decidedly more important in the training of men for the automotive industry and engineering in general than anything else, it is a working knowledge of the English language, asserted Charles H. Paxton, instructor at the University of California.

Whirlwind and Cyclone Discussed

E. T. Jones Tells Milwaukee Section of Special Features and Latest Developments in Wright Radial Air-Cooled Engines

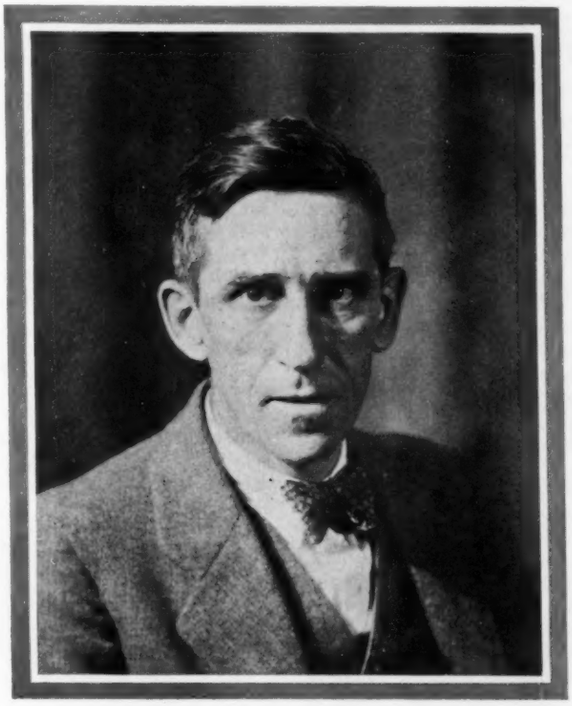
Development of the Wright Whirlwind engine, its design, construction and production, were described by E. T. Jones, chief engineer of the Wright Aeronautical Corporation, and discussed at length by members in attendance at the regular monthly meeting of the Milwaukee Section on Nov. 2 at the Milwaukee Athletic Club. The meeting was attended by 240 members and guests, of whom 202 registered for dinner. It was the largest meeting in the history of the Section.

Upon opening the meeting, Chairman Fred M. Young called for nominations for Section members to act as a delegate and an alternate to represent the Section on the Sections Committee and as a member and an alternate on the Nominating Committee for the nomination of officers of the Society for 1929. John J. Balsom, of the Harley-Davidson Motor Co., was nominated as delegate, and Walter S. Nathan, of the Nash Motors Co., as alternate. Both were elected unanimously.

The chairman then extended the welcome of the Section to the guests at the meeting and asked Mr. Bloodgood, civilian aide to the Secretary of War, to say a few words to the assemblage regarding his attitude toward aviation. It is Mr. Bloodgood's conclusion, in which he finds that men who have made a study of the problem concur, that because of modern weapons and inventions, a percentage almost as small as 0.1 per cent of the male population of a civilized community, if properly organized and in control of the air by means of high explosives, transportation and communications, can hold in abject slavery the other 99.9 per cent of the male population even if the latter are armed with modern repeating rifles.

This means that in America we must have the help and support of trained men. At present the United States is not on a par with other countries in defence and offence in the air, he said, and therefore everything that is being done for aviation, whether commercial or not, is of great importance to the Country. As a result of the interest that has been aroused in aviation, he believes the military training organizations and the general staff of the Army will receive great assistance.

History of the Whirlwind-engine development was sketched briefly by Mr. Jones, who then showed a series of slides of the engine and its parts and described their special features. Most of these have been shown and described in previous issues of THE JOURNAL[1]. In addition, he showed some slides of special applications of the J-5 model, including one fitted with a Roots supercharger as used in some of the Navy's fighting airplanes, and one with a generator drive and a mechanical engine-starter. The starting device consists of a hand-crank, a gear train and a small flywheel. In operation, the mechanic turns the crank until the small flywheel is rotating at a high rate, then trips a switch to throw the flywheel into communication with the crankshaft through the gear train, so that the momentum of the flywheel turns the crankshaft until the engine fires.



E. T. JONES

A carbureter air-heater was also shown, the addition of which to the engine was found advisable to assure satisfactory operation in cold, damp weather. This is now part of the standard equipment, said Mr. Jones. Engine-performance curves also were shown and explained. When installing an engine in an airplane, it is necessary that the engine power-output be equal to the power required to drive the propeller, so as to arrive at a constant speed. Roughly, the propeller power curve follows the engine power curve. With a propeller designed to take the full power of the engine at a propeller speed of 2000 r.p.m., the curve shows a power input of about 235 hp., but if the propeller speed could be checked down to 1600 r.p.m., the power it could absorb would be about 120 hp. It is possible, asserted Mr. Jones, to throttle this 200-hp. engine down to an output of 65 hp. and still maintain a fuel consumption of 0.35 lb. per hp-hr.

He is often asked what is the next step in aeronautic-engine development, said Mr. Jones. For the Wright company, the next step is the development and production of a larger engine for commercial airplanes that will carry larger loads of mail, express, freight, or passengers. Several pictures of such an engine were shown.

NEW CYCLONE ENGINE PERFORMS WELL

Other pictures showed installations of Whirlwind engines in Lindbergh's Spirit of St. Louis, in the Bellanca airplane used by Clarence Chamberlin in making endurance records and in his flight with Charles Levine across the Atlantic,

[1] See Air-Cooled Engines in Naval Aircraft, THE JOURNAL, Sept. 1926, p. 221; The Development of the Wright Whirlwind Type J-5 Aircraft-Engine, THE JOURNAL, Sept. 1926, p. 303; and The Wright Whirlwind Engine Production Methods, THE JOURNAL, October, 1927, p. 361.

and of the Wright Cyclone engine which the company has been developing for the Navy. One of the Cyclone engines had been out for about a month, said Mr. Jones, and its performance was very pleasing. The construction is very similar to that of the J-5, but the magnetos are placed on the rear, as airplane manufacturers object to having the magnetos on the front, where they are exposed to rain and the full effects of bad weather.

An interesting feature of the engine that is being tried out more or less experimentally is the placing of the exhaust ports at the front instead of at the rear or side of the cylinders. This makes it possible to place the exhaust manifold in front. The manifold is light, small in diameter and does not interfere materially with the cooling of the cylinders. It is also out of the line of the pilot's vision between the upper cylinders, where a red-hot manifold at night greatly annoys the pilot. Placing the manifold in front also greatly reduces the fire risk from gasoline coming into contact with the manifold because of a leak or in case of a crash.

Owing to the difficulty of making the master connecting-rod stiff enough in the larger engine, it has been necessary to make the crankshaft in two pieces and the connecting-rod in one piece. The construction is exceedingly simple, the separate rear section of the shaft slipping over the crankpin and being drawn up tight with a 1⅛-in. cap-screw. This engine is rated at 525 hp. at 1900 r.p.m., and the horsepower curve shows 565 hp. at 2000 r.p.m.

Discussion Shows Members' Keen Interest

Keen interest of the members in the Whirlwind engine was shown by the extended discussion. Chairman Young suggested that Mr. Jones tell how the crankshaft is balanced. More questions are asked about the master connecting-rod and how all the nine cylinders work on the one crankpin than about any other feature, according to Mr. Jones. The master rod is connected to the piston in the top cylinder. The eight articulated rods connected with the master-rod big-end rotate around slightly modified circles. The force from all the cylinders is carried through the big end of the master-rod and is transmitted to the crankshaft through the one bearing. Equal piston strokes are secured by adjusting the positions of the various link-pins so they do not correspond exactly as to angle and to distance from the crankpin center. The customary firing order of radial engines is: 1, 3, 5, 7, 9, 2, 4, 6, and 8. This skip arrangement is necessary to secure equally spaced firing with an odd number of cylinders.

Side-thrust on the cylinders varies considerably among the different cylinders, said Mr. Jones in response to a question by J. C. Slonneger. The articulated rods exert a rotative movement on the master rod, which is equalized by side-thrust on the piston. It has not been noticed that the master-rod piston wears faster than the others but the wear is distributed over the entire piston-wall, whereas on the other pistons the wear is mostly at the top and bottom.

Standard babbitt-metal is used in the bearings, the speaker said in reply to a question by Robert Schultze, but he did not believe a connecting-rod bearing had ever burned out.

Flooding of the lower cylinders with oil, inquired about by Louis W. Falk, does not occur because the cylinder barrels project up inside the crankcase a fair distance, and piston speed is so high that the effect of gravity on the oil in the cylinders is almost negligible. To prevent freezing of oil in the oil line, which is of ⅝-in. inside diameter, the tubes are covered by insulation.

Although a rotary supercharger never has been used in the Whirlwind engine, which would have to be redesigned to build such a supercharger into it, this type of distributor has been built into the larger engine, said Mr. Jones in reply to a question by Lee W. Oldfield.

Details of Self-Cooling Exhaust Valves

It is absolutely impossible for the exhaust valves of the engine to heat to a visible red, according to the speaker. As the head of the valve is a fair proportion of the surface of the combustion-chamber, this means a cool combustion-chamber and less tendency to detonation; which, in practice, means that the engine can be run at very low fuel consumption without overheating. The valves are self-cooled; the stems are approximately ½ in. in diameter and are made hollow to as close to the valve head as possible, and the cavity is filled about 60 per cent full of a mixture of sodium nitrate and potassium nitrate, which melts at a temperature of about 700 deg. fahr. This liquid salt mixture is agitated as the valve rises and falls, so that the liquid splashed against the head conducts the heat to the end of the valve stem faster than it would be conducted through the metal of the stem. The salt mixture is introduced in a molten condition after the valve has been preheated, after which a plug is driven into the swaged end of the stem. This salt-cooled valve construction, together with the development of some new valve seats, has entirely eliminated the problem of exhaust valves in air-cooled engines, Mr. Jones declared.

The advantage of the stationary radial type over the rotary type of air-cooled engine, said Mr. Jones in reply to Chairman Young, is that it can operate at higher speed. Even at speeds of 1400 or 1500 r.p.m., 10 per cent of the power was required to drive the rotating cylinders against air resistance, and at an engine speed of 2000 r.p.m. about 25 per cent of the power would be needed just to keep the cylinders rotating. Moreover, centrifugal forces are high in the rotary engine.

Operating Temperatures of Air-Cooled Engine

Cylinder-wall temperatures of 250 or 300 deg. fahr. are regarded as normal, he said in reply to Anton F. Brotz. With a customary installation having reasonably good cooling, when flying at ordinary full-throttle opening, the temperature at the rear of the cylinder barrel is from 250 to 270 deg., or about 50 to 60 deg. higher than the temperature at which a water-cooled engine can operate without boiling.

None of the later Whirlwind engines has been running long enough to determine the life of the engine in flying hours. Most of the airlines estimate the life at 2000 hr., equivalent to about 200,000 miles. Many of the engines have now reached this length of service, and about half the engines in a group of 10 used on the Air-Mail line on the Pacific Coast have run more than 3000 hr. and are by no means ready for scrapping. The life of the engine can be prolonged almost indefinitely if care is taken to have it running with clean oil and to avoid overheating and overloading it. The Wright company recommends overhauling after 250 to 300 hr. of flying, or on a 25,000-mile basis.

Asked by a member regarding the effect of water or sleet on the engine, the speaker said that these dry off as quickly as they strike the engine. No effect has been noticed in ordinary snow and sleet storms.

Production of the Whirlwind engines, he said in reply to another question by the same member, was 80 in October.

ENGINE LUBRICATION CONSIDERED

Dr. Wilson Describes and Illustrates This Subject for Pennsylvania Section

Dr. R. E. Wilson told of recent developments in engine lubrication at the regular monthly meeting of the Pennsylvania Section, held on Tuesday, Nov. 15, in the rooms of the Philadelphia Automobile Trade Association. He illustrated his address with motion pictures and sketches and with demonstration apparatus that showed the flow of oil in a bearing at different loads.

Following the convening of the meeting by Vice-Chairman P. M. Heldt, Secretary W. H. Metcalf, of the Philadelphia Automobile Trade Association, extended to the members of the Pennsylvania Section a very cordial invitation to make use of the Association's rooms.

Mr. Heldt then called for nominations for a member to represent the Section on the Nominating Committee of the Society, and for nominations for a member to act on the Sections Committee of the parent organization. B. B. Bachman was thereupon nominated and elected to serve on the

Nominating Committee, and E. W. Templin was nominated and elected as a member of the Sections Committee. After this, the meeting was turned over to Mr. Bachman, who presided during the rest of the evening.

C. O. Guernsey then proposed a resolution endorsing the activities of the American Red Cross in connection with its relief work following the Florida hurricane, during and after the floods along the Mississippi River and in New England and following the recent gas-tank explosion in Pittsburgh. He proposed that the resolution also endorse the campaign of the Red Cross for membership. His suggestion was put into the form of a motion, which was seconded and passed unanimously.

In introducing Dr. Wilson, Mr. Bachman said that the Meetings Committee of the Section, in deciding upon topics for discussion at the meetings to be held during the coming winter, thought that there was no more important subject at the approach of cold weather than lubrication, and could think of no one better qualified to address the Section on this subject than Robert E. Wilson, of the research council of the Standard Oil Co. of Indiana.

Before beginning his address on lubrication, Dr. Wilson said that he brought the greetings and congratulations of the Chicago Section to the Pennsylvania Section.

Following Dr. Wilson's address, B. B. Bachman, acting as chairman, stated that it seemed to him that a very unfavorable condition for lubrication exists at the piston-ring, because the maximum pressure is imposed on the piston-ring or by the piston-ring on the cylinder-wall at the time of zero velocity, probably when the piston is at the upper end of the stroke and when the maximum explosive pressure is reached. This, it seems to him, is one of the big problems in securing satisfactory lubrication in an engine cylinder, and he said that he did not know that anyone had come forward with a practical suggestion for overcoming this condition.

Extended discussion followed the presentation of Dr. Wilson's paper, but must be reserved for later publication in connection with the paper itself.

New Problems in Body Design

Low Cars and High Speed Necessitate Chassis Engineers' Aid, Buffalo Section Is Told

"If the executives controlling the destinies of our automobile companies continue to demand lower bodies, because the public likes them, it is going to become the duty of the chassis engineers to come to the rescue of the body engineers with a practical method of reducing the frame kickup and the size of the rear-axle housing while still giving spring travel that is conducive of comfortable riding," asserted Alben F. Carlson, body engineer of the Pierce-Arrow Motor Car Co., in a paper on Body Design which he delivered at the meeting of the Buffalo Section on Nov. 1.

Continuing, he said:

> If it is possible, the body engineer should be consulted when the chassis frame is first considered, for low bodies cannot be built on improperly designed chassis. The ultimate has practically been reached with the present conventional type of power transmission. One possibility that is not so remote as may seem is front-wheel drive, which would erase all the troublesome cares connected with the designing of low bodies by eliminating the chassis kickup at the rear and the rear-axle housing. The rear wheels could be suspended separately, without using a rear axle, or the axle could be bent channel shape under the rear of the body. The body could then be entered from the curb without the use of a running-board, and the only limiting factor on the over-all height of the car would be the road clearance of the chassis frame itself. The car would ride easier and the reduction of 4 sq. ft. in the frontal area would allow either a reduction in horsepower or an increase in car speed, because more than 75 per cent of the power needed to drive a car at 60 m.p.h. is used to overcome wind resistance.

A Radical Body Designed for Speed

The speaker showed a slide of "a most modern design" of five-passenger sedan body which he said is ready but has not been presented to the public for its approval. The radiator is high and the line of the top of the hood and cowl approaches the horizontal; with the length of the hood and the lowness of the body, this gives a pleasing forwardly sweeping motif. The visor is designed to be built into the body. Despite the lowness, the rear seat cushions are generous in proportions. Proper streamlining has reduced the frontal area another square foot. It is impossible today to produce a car of this type and expect it to sell, according to Mr. Carlson, because the public is unaccustomed to seeing such a "freak." When, in the future, all States have removed the speed limits on their highways, and people think nothing of traveling 60 m.p.h., they will want cars that are streamlined like an airplane and that will slip through the air with the minimum effort.

Most of the speaker's address was devoted to a description of the work involved and the methods used in designing, laying out, making patterns for and finally building high-grade bodies. Chassis dimensions that limit the body dimensions were mentioned, and important items in the body designer's stock-in-trade were said to be the wheels, fenders, radiator, lamps and running-boards. Characteristics that differentiate bodies consist mainly of outside embellishments, such as moldings, visors and glass fronts. The radiator, hood, cowl and fenders are the common identifying marks.

Although Mr. Carlson had shown some designs that seemed radical, said J. C. Talcott, experimental engineer of the same company, in discussion, he thought they were no more radical today than today's cars are by comparison with those of 1905. Considerable development work will have to be done, however, before front-wheel drive becomes a reality; although this type of drive has been used in racing cars for the last 3 years, he said he did not think that a front-wheel-drive car ever finished first in the Indianapolis race. If the engine is placed above the front axle of such a car, the hood will be too high to see over.

Design Should Simplify Body Repairing

In what ways has the body designer attempted to work out some of the problems of body repairing that confront the service man? inquired E. W. Kimball, of the Vacuum Oil Co. From his experience, it had always seemed to be necessary to take a car to a body shop for simple operations, such as replacing the lower velvet channels under the windows, which he always felt is a job that an ordinary service station should be able to do if provision is made in the design for upholstering so that this can be accomplished easily. He suggested the possibility of designing removable channels for the door glass, which is more often broken than that in the side windows.

Mr. Carlson replied that in general his company uses a rubber channel covered with felt, which does not give trouble, but in the event that it should do so, it would be necessary to remove the trimming and take it out. In taxicab work, the trimming is put on with screws and when assembled in the body the screws show. It is easily removable but is not

quality work. It is not necessary to remove the trimming to replace a door glass, he said, but if anything goes wrong with the window-operating mechanism, it is necessary to remove the trimming.

Rattling of windows is difficult to overcome, admitted Mr. Carlson in response to a query by J. W. White, of the Wire Wheel Corporation. One way is to make the channel of spring brass. In a quality car the window-run channel is of a design that should prevent rattling.

G. Crosier suggested that a projecting visor might retard the speed of a car by creating a vacuum underneath it; and Mr. Carlson said he believes it would have such a tendency.

Weight cannot be saved by using thinner glass, as suggested by D. S. Cox, research engineer of the Pierce-Arrow Company, according to Mr. Carlson. It is necessary to use plate glass to avoid distortion of vision, and if the glass is less than 5/32 in. thick it is more liable to breakage. Triplex glass is heavier, he thinks, than regular plate glass, as it has a sheet of celluloid between two sheets of glass.

Suggests Eliminating Chassis Frame

Weight of street-cars has been reduced considerably by making the body stiff enough to carry its own weight, according to one member, who suggested that the saving in weight by such construction of an automobile body might be sufficient to warrant working along this line, placing the engine and the wheels directly on the body instead of on a chassis frame. This is a question of chassis design rather than body design, said Mr. Carlson; and Mr. Talcott said that although it has not been tried in this Country, a foreign car has been built with the body hung right on the axles; a great deal of work would need to be done, however, to perfect such a design.

An increase of 10 or 15 hp. will not increase speed very much at speeds above 70 m.p.h., as 75 to 80 per cent of the power is required to overcome wind resistance; therefore the thing to do is to educate the public to the change in design necessary to overcome wind resistance, declared Mr. White. Streamlining alone will add very little to the speed with the present conventional style of frame and with the power transmitted through the wheels, according to Mr. Carlson; the greatest stride can be accomplished by reducing the frontal area.

Most Troubles Due to Faulty Work

Mr. Kimball referred to such troubles as cowl-panel breakage, leaks around windows, rattling doors, breakage of door-check straps, and cutting through of the combing around the rear seat. Poor manufacturing accounts for most of these, asserted Mr. Carlson; when a body job goes into production, no matter how carefully it is watched, the various parts are not put into the body with the care that should be expected. Window rattles will be eliminated if the proper channel is used. Panel breakage, which probably is due to rust in steel bodies, could be avoided by bracing the body so thoroughly that the panels could not move. Water leaks around the windshield are due to faulty workmanship; to safeguard against water getting into the car, the windshield in the Pierce-Arrow bodies is sealed on the inside in such a way that water that comes in will find an easy way out. Joints properly made and glued should not squeak; if a squeak develops, there is no hope, said Mr. Carlson. Doors are the hardest worked part of the car, and door rattles will come in the best cars; the only possible chance to overcome them is to pack behind the worn rubber door-bumpers or replace them with new ones. Hinges should never become sprung if the door is fastened properly. Door check-straps should last forever if the door is opened and closed properly, but if an owner opens a door that is hinged at the rear when the car is running, the wind resistance will break almost anything.

Asked by W. W. Slaght, of his own company, whether the problem of water leakage in rear-deck runabouts has been solved, Mr. Carlson replied that he thinks this difficulty has been overcome by putting in a larger drain trough and pipe to carry away the water that gets in during washing of the body; the decks do not leak rain-water.

Use of aluminum panels instead of steel saves about 200 lb. in the weight of the Pierce-Arrow bodies, but at 60 m.p.h. weight reduction does not help much, according to Mr. Carlson. Experimental work done with an aluminum chassis about 2 years ago reduced the total car weight 600 lb., and the car held the road as well as the standard car, said Mr. Talcott. Some gain in maximum speed can be made by reducing the weight 1000 lb., which would bring the power required to drive the car at the peak of the engine power.

IT WAS A FAIRCHILD MONOPLANE

By error, the caption under the engraving on p. 591 of the November number of THE JOURNAL, showing a group of Buffalo Section members inspecting an airplane at the Buffalo municipal airport, stated that the monoplane was a Ryan. This is corrected in a letter by R. M. Kincaid, vice-president and general manager of the Fairchild Airplane Mfg. Co., who states that it is a Fairchild cabin monoplane belonging to E. M. Ronne, of Buffalo.

MEETINGS OF THE DAYTON SECTION

The subject of the regular monthly meeting of the Dayton Section, scheduled for Nov. 29, at the Engineers' Club in Dayton, Ohio, was Characteristics and Field of Usefulness of the Motor Truck, and the speaker was B. B. Bachman, of the Autocar Co.

At the next regular meeting, scheduled for Dec. 5, at the same place, the speaker is to be R. H. Grant, of the Chevrolet Motor Co., whose subject is How To Sell Automobiles.

PACIFIC COAST TRACTOR USAGE

Northern California Section Discusses Local Conditions for Tractor Operation

West Coast conditions that have special effects on the operation and maintenance of tractors used there were presented in a paper by Howard A. Reinhart, of the Robinson Tractor Co., Oakland, Cal., at the meeting of the Northern California Section held at the Athens Club, Oakland, on Nov. 10.

The technical session was preceded by a dinner, and before the presentation of the paper motion pictures of tractors in operation were shown and a lively discussion transpired regarding skid chains, whether their use is desirable or not, and their effect on tires. At the business session, H. L. Hirschler, of the Horace Remote Control Co., was elected as Section representative on the Society's Nominating Committee. W. S. Penfield, of the Associated Oil Co., presided as chairman of the technical session.

Major Operations for Tractors

Enumeration of the major operations on the Pacific Coast for which tractors are suited, of the methods superseded by their usage, and of the economic results thus attained, formed the basis of Mr. Reinhart's paper. He mentioned agricultural usage of tractors first because the vast delta lands of California make necessary some means of traction other than that of the wheel type, such as the track-laying type.

Tractors of the last-mentioned class are used now to do all the work in the peat lands, to cultivate farms and orchards, and as motive power for harvesting machinery that formerly was horse-drawn. Mr. Reinhart said that the most severe service demanded at present of tractors is the leveling of sand dunes in some of the Coast cities, grading for building purposes and the like. In this work, the cost has been reduced approximately 45 per cent by the use of tractors as compared with the former cost.

Tractors also are an important factor in effective and economical road-building. In fact, the speaker said that to

(*Continued on p.* 713)

Chronicle and Comment

The Annual Meeting

AS indicated in the Meetings Calendar, the Annual Meeting will be held Jan. 24 to 27, 1928, inclusive, at the Book-Cadillac, Detroit, during the week preceding the Chicago Automobile Show.

No Carnival at the Annual Meeting

UPON recommendation of the Meetings Committee, the Council has approved the decision of the Committee to hold no carnival in connection with the Annual Meeting in January.

The Annual Dinner

IN accordance with the usual custom, the Annual Dinner will be held on Thursday evening, Jan. 12, 1928, during the week of the New York Automobile Show, at the Hotel Astor. Arrangements are now being made for the dinner under the direction of F. K. Glynn, chairman of the Annual Dinner Committee. Several innovations are promised.

The 1928 Sections Committee

EIGHT members of the 1928 Sections Committee have been elected, one from each of eight Sections. After the other five Sections have chosen one representative apiece for the new Sections Committee, the Committee will be complete, except for three members-at-large, who will be appointed by the President within 30 days after he takes office. The new Sections Committee will begin to function at the opening of the Society's administrative year, starting at the close of the Annual Meeting in January.

A Splendid Meeting

CONGRATULATIONS to the Detroit Section! At its meeting on Nov. 7 in the grand ball room of the Book-Cadillac, the new headquarters of the Detroit Section, 540 members and guests enjoyed an excellent dinner and more than 700 attended the meeting at which Edward Schlee and W. B. Stout were the headliners. Dancing followed, with music by the inimitable Detroit High Hat Orchestra. A new standard has been set for Section meetings which few Sections can be expected to equal. A complete report of the meeting will be found on p. 623.

New Era of Transportation

IT is well at times for each person engaged in a restricted field of activity to get the broader perspective of that field as seen by a capable observer who is not in the center of it. Such an opportunity is afforded to motor-vehicle manufacturers and to automotive transportation men by this issue of THE JOURNAL, in which a special editorial article by J. F. Winchester and a leading paper by Brigadier-Gen. Francis H. Pope present observations on transportation from the viewpoints of the commercial and the military users of automotive transportation.

The competence of Brigadier-General Pope to write on the subject of military transport is sufficiently reflected in his able paper. Mr. Winchester's editorial, printed on the following page is of special interest because of the author's practical experience as an operator and his activities in the Society. He is a Councilor of the Society; a present member of the Operation and Maintenance Committee, the Meetings Committee, and the Research Committee; and was a member of the 1927 Transportation Meeting Committee and Chairman of the opening session of that meeting.

A War Memorial to Engineers

IN rebuilding the Library of Louvain, which work has been financed by American funds, it was decided that a clock and carillon should be installed in the tower of the building and be dedicated as a memorial to the American engineers who gave their lives in service outside of this Country during the World War. For this purpose the leading engineering societies of the United States are cooperating to raise among their members the necessary sum of $80,000 so that the work may be completed in time for the dedication of the building next May or June. The Society is mailing printed matter to the membership regarding this and will be glad to handle any contributions that are made.

An Important Section Duty

THE Society's Constitution provides that the Annual Nominating Committee shall consist of one Member of the Society to be chosen from and by each Section prior to the Annual Meeting, and three members of the Society who shall be elected at the business session of the Annual Meeting preceding the Annual Meeting at which officers are to be elected. The organization meeting of the Nominating Committee will be held in Detroit during the week of Jan. 24, 1928; that is, while the Annual Meeting is in session. It is therefore necessary that each Section elect a representative prior to the Annual Meeting, as well as an alternate to serve if, for any reason, the representative is unable to fulfill his duties.

Radio and Airplane in Flood Relief

IN his talk at the meeting of the Detroit Section, early in November, Mr. Stout mentioned the close relationship between radio and the airplane. An incident that occurred the same week, during the recent flood in Vermont, illustrates this and also shows how priceless airplane transportation may be in some cases. When Montpelier was completely isolated from the outside world, an amateur radio operator sent out a call for yeast to enable the local bakery to provide bread for the people of the city. Within 12 hr. the yeast came, dropped from an airplane that could not have found a safe landing place within many miles of Montpelier.

Airplanes were used in many other ways to aid in the relief of the flood-sticken area at a time when all other modern means of transportation and communication were broken down.

Automotive Transportation

By J. F. WINCHESTER[1]

COORDINATED transportation has had a far-reaching influence in the development of the economic resources of the world, and it, combined with an audacious pioneering spirit, rather than any other agency, has been responsible for the Country's rapid development.

This year has witnessed, at Baltimore, the celebration of the one-hundredth anniversary of the founding of the Baltimore & Ohio Railroad. It consisted of a pageant called The Fair of the Iron Horse, in which were shown all types of transportation, except the automobile, that have been used in America from the days of De Soto down to the present time. The 80,000 to 82,000 people in daily attendance had an opportunity to see in concrete form the crude methods of transportation of colonial days as compared with the modern locomotive and luxurious Pullman cars of today. It was a show, or demonstration, of great educational value; one in which every American could visualize the hardships his forefathers had gone through to make possible present-day conditions, and one of which any American or railroad man, particularly those connected with an institution like the Baltimore & Ohio Railroad, could be proud.

As this review of progress passed before me it caused me to fill with pride as I looked over the automobile parking space, which consisted of acres and acres of land holding thousands of automobiles that had served as a partial medium of transportation to the vast throng interested in the show; and it occurred to me that no transportation agency had had such a marked effect upon mankind as has the automobile in its quarter century of existence. I thought of the wonderful growth of this industry, which in that short time had grown to such magnitude that it resulted in 3,500,000 persons being employed directly and indirectly, as compared with the 1,800,000 employes of the railroads, and again of the fact that 70,000 more folks were employed as professional chauffeurs, truck drivers, mechanics and helpers than the grand total of rail workers of all kinds.

Again I could see that no agency of transportation had had such a marked effect upon mankind as the automobile had in this length of time. Within that period it has effected changes upon the fundamental principles of society that had become established through tradition. All types of business institutions have accepted principles of conduct and management that seemed impractical before its advent.

What a revelation it is to go through a modern automobile factory and see the ideal working conditions that prevail, as compared with the shop of my early apprenticeship days. We find the factories well lighted and ventilated, clean, sanitary, and organized to a high degree, the men working a 20-per cent shorter day and yet producing more units per man than ever before, and with such cordial industrial relations existing that labor troubles are reduced to the minimum. We find educational and recreational opportunities provided for the men, and wages sufficient to furnish personal automotive transportation for most of them. Where is the automotive engineer who is not proud to have taken part in such an achievement and to be affiliated with such an industry?

We can look to the future with an optimistic spirit. The accomplishments of the past have created new types of industrial giants—Sloan, Ford, Schwab, Farrell, Firestone, Teagle and others—whose faith in American institutions and great industrial opportunities is resulting in the carrying of American products to all corners of the world. With the cooperation of such geniuses as Edison, Kettering, Hewett, Ford, Midgely and Crane, engaged in scientific research for the development of new ideas, ways will be developed that will make present practices obsolete.

Opportunities for economical application of organized automotive transportation will continue to grow. Possibilities of more numerous applications in large cities are constantly seen by the ever-increasing use of private automobiles and the resultant parking problem. Subways for the electric railway in congested areas and for automobile roads are a coming necessity. The application of automotive ideas to electric or steam-railway operation will not act as a substitute for the type of transportation to which the public has become educated and demands. Potential opportunities for coordination with the railroads are far from exhausted, and the possibilities of more economic use in congested areas are presented by the recently completed Holland Tunnel, the Philadelphia and Camden Bridge, the proposed Hudson River Bridge, and similar public works.

With the rapid expansion of the airplane industry we find another opportunity for coordination. Automotive express service from flying-fields to civic centers is a necessity if the time gained by this new type of transportation is not to be lost.

There is a distinct opportunity for improvement and lower costs through more uniform requirements if the various State laws on automotive transportation are coordinated along standardized lines. What is needed to accomplish this is closer cooperation by the local civic bodies and legislatures with an organization like the Society of Automotive Engineers.

I can see great possibilities of lower transportation costs through the employment of the later types of motor-vehicle as compared with the earlier models. The later machines have reached a high degree of mechanical perfection, and the possibilities of keeping them on the road between periods of overhaul are increased two or three times as compared with models of 7 or 8 years ago. While fleet owners and private individuals always will encounter mechanical difficulties that will need to be studied and eliminated by the manufacturer, the number of these will be few as compared with the past. Experimental work of such an exhaustive nature is being done on such a scientific basis that the possibilities of early failure of the new models are remote as compared with the old types.

World-wide markets for the application of this tool are still to be conquered. The year 1927 will see more than 400,000 cars exported, or more than the entire yearly production of 15 years ago. Pioneers of commerce, under the able guidance of industrialists and of the Government, through the Secretary of Commerce, will surely continue to open markets which hitherto have lain dormant.

[1] M.S.A.E.—Superintendent of motor equipment, Standard Oil Co. of New Jersey, Baltimore.

J. F. WINCHESTER

Personal Notes of the Members

Grover C. Loening, in a letter to Porter Adams, president of the National Aeronautical Association, has announced his intention to set aside $5,000 to establish a prize fund for an intercollegiate flying contest, the contestants to be students in American institutions of college rank. While expressing his belief that a flying contest among students would be a stimulus toward the development of aviation in our colleges, Mr. Loening stated that, in his opinion, a college contest should avoid placing a premium on reckless flying of the sort which some racing involves. "It might conceivably be a contest of skill, expert piloting and knowledge of one's individual machine," he said. "For example, a race to altitude would demand the utmost of a pilot and his airplane, at the same time keeping the entire performance within sight of the spectators." In accordance with Mr. Loening's plan, Mr. Adams will select a committee to cooperate with the donor in working out the necessary details in connection with the contest.

Mr. Loening has been actively engaged in aeronautical pursuits since he was a student at Columbia University, where he received in 1911 an engineering degree in aeronautics, the first degree of that kind to be conferred in this Country. To quote indirectly from the letter mentioned above, it was the encouragement which he received there from the president of the university and certain members of the faculty during his early experiments that led him to seek a career in aviation.

After graduation he became, successively, chief engineer of the Queen Aeroplane Co., New York City; general manager of the Wright Co., Dayton; chief aeronautic engineer of the Army Air Service; vice-president and general manager of Sturtevant Aeroplane Co., Boston, and, in 1920, president of the Loening Aeronautical Engineering Corporation, New York City.

For 11 years Mr. Loening has been a valued member of the Society, having been elected to Member grade in 1916. He has served on the Publication Committee, and has been for many years a member of the Aeronautic Division of the Standards Committee. He has also taken an active part in the Society's work on the Aeronautical Safety Code.

Mr. Loening has written several books on aeronautical subjects. He has also been a speaker at various meetings of the Society, and his papers that have appeared in THE JOURNAL include the following: Making the Airplane a Utility, June, 1919; Engine Shape as Affecting Airplane Operation, June, 1920; Design Requirements of Commercial Aviation, February, 1921; and Amphibian-Airplane Development, May, 1926.

Donald B. Brooks resigned recently as laboratory engineer in the research department of the Studebaker Corporation of America, South Bend, Ind., to return on Nov. 10 to the Bureau of Standards, City of Washington, as associate engineer. In his new position he succeeds J. O. Eisinger, who is now with the Standard Oil Co. of Indiana, as stated in the October issue of THE JOURNAL. Mr. Brooks will therefore be active in the Cooperative Fuel Research which, since 1922, has been in progress at the Bureau under the auspices of the American Petroleum Institute, the National Automobile Chamber of Commerce and the Society.

Mr. Brooks became assistant engineer in the automotive powerplant section of the Bureau of Standards immediately after his graduation from Ohio State University in 1922. Leaving the Bureau, he accepted a position as research mechanical engineer with Boyce & Veeder, later becoming engineer in the mechanical department of the Texas Co., and resigning in 1926 to enter the employ of the Studebaker Corporation of America.

An Enrolled Student in 1922, Mr. Brooks was elected to Junior Member grade in 1924 and has participated in the work of the Society by presenting papers of exceptional merit at a number of the Society's meetings. The following papers written by Mr. Brooks have appeared in THE JOURNAL: Tests of Carbon Deposition in Internal-Combustion Engines, January, 1926; The Quantitative Effect of Engine Carbon on Detonation, in collaboration with Neil MacCoull, July, 1927; Oil-Flow through Crankshaft and Connecting-Rod Bearings, in collaboration with S. W. Sparrow, August, 1927.

G. P. Hall has been made sales representative, with headquarters in the Garfield Building, Detroit, for the Dole Valve Co., manufacturer of thermostats, primers, compression couplings, and brass fittings.

A varied experience, beginning in 1910 with road testing and experimental work for the Dayton Motor Car Co., has given Mr. Hall a splendid background for the present position. Since 1912, when he left the Dayton company, he has been connected successively with the Air Friction Carburetor Co., as assistant shop superintendent; with the Delco Co., as service representative; with John O. Heinze Co., as service manager; with the Aircraft Division, United States Army, stationed at Dayton, in charge of all electric inspection of the DH-4 airplanes in the central district; with the Ericsson Mfg. Co., as district manager; and, from 1922 until a month ago, with the Westinghouse Union Battery Co. in the capacity of central district manager of manufacturers' sales, with headquarters in Detroit.

Mr. Hall was elected to Associate Member grade in the Society in 1922. He has been an enthusiastic member of the Detroit Section for several years and is now chairman of the Membership Committee.

J. Walter Drake, after 4 years of public service as Assistant Secretary of Commerce, has resigned to re-enter private business. In a letter expressing regret at Mr. Drake's resignation, President Coolidge praised his devoted service to the American people in the upbuilding of our commerce and industry, stating that Mr. Drake has served "not only the industries and business, but the stability of employment, and thus the whole people."

Mr. Drake's career is too well known to call for comment in these columns. After graduation from the Detroit College of Law in 1896, he practiced law in Detroit until 1908, when he became the active executive head of the Hupp Motor Car Corporation. At the time of his appointment as Assistant Secretary of Commerce, he was chairman of the board of directors of the corporation.

Mr. Drake has been connected with the Society since 1914, when he became an Associate Member.

Chester S. Ricker has been made vice-president of Day-Nite, Inc., Waukesha, Wis. He will continue to be associated with the Waukesha Motor Co. in the capacity of advertising counsel.

Mr. Ricker's interest in the automotive industry dates back to 1910, when he was elected to Junior Member grade in the Society while a student at Sibley College, Cornell University. He has been an active member of the Society since that time, having been transferred to Member grade in 1916.

Several articles by Mr. Ricker have appeared in the publications of the Society, as follows: Automobile Contest Timing and Coaching, TRANSACTIONS, 1911; Silent Chains, TRANSACTIONS, 1912; Valve Action in Relation to Internal-Combustion-Engine Design, in collaboration with John C. Moore, THE JOURNAL, September, 1922, and TRANSACTIONS, 1922.

Frank M. Kincaid has been made axle engineer in charge of the axle division of engineering for the Relay Motors Corporation, Lima, Ohio. As announced in the September

(*Continued on p.* 18 *of the advertising section*)

Automotive Research

THE MECHANICAL DETERIORATION OF VEHICLES

H. M. JACKLIN

While at Ohio State University I had the pleasure of supervising the preparation of a senior thesis by U. J. Grant, P. A. Harlamert, W. A. Meiter, and R. S. Osborn, wherein they attempted to find the economical life of commercial passenger-vehicles. Although their work was necessarily incomplete because of the lack of time and of certain parts of the history of the vehicles tested, the methods used in testing and some of the results obtained should be very interesting to all concerned with the performance of motor-vehicles. A brief preliminary report on these tests was presented in a recent number of this publication[2].

The tests show that mechanical deterioration has a decided influence on the performance of vehicles. The ability of the engine to develop power economically decreases, but this falling off in performance contributes only slightly more than does the deterioration of the transmission system to the total effect of aging. The faults of the engine can usually be sensed easily by the operator or the service man. The faults in the transmission system can be sensed, but usually are ascribed to the engine. Chassis dynamometer-tests show exactly where the faults lie and thus point the way to possible remedies.

One of the methods by which research aids maintenance is indicated in this article. In it Prof. H. M. Jacklin[1] tells how four students at Ohio State University measured for 14 vehicles of various ages the effect of wear on power production and fuel consumption. The equipment used, procedure followed and results obtained are described in detail.

This study may be regarded as the forerunner of a more complete and extensive investigation now being planned by Professor Jacklin with equipment available at Purdue University.

From observations made over a larger interval of time on a great number of vehicles concerning whose service more exact data are known, conclusions may be drawn that will be a scientific guide to maintenance.

VEHICLES IN FIVE MILEAGE CLASSES TESTED

The vehicles tested in this investigation were 14 Yellow Cabs furnished by the Columbus Transfer Co. No exact mileage or service records were available for these cabs, so they were placed in a mileage class by assuming that they had averaged 600 miles per week from the date of delivery. On this basis, these cabs were grouped in five classes, as follows: (*a*) 40,000 miles, (*b*) 50,000 miles, (*c*) 75,000 miles, (*d*) 110,000 miles, and (*e*) 140,000 miles.

Only two cabs were tested in the 75,000-mile class. Three cabs were available in each of the other classes. The cabs in the 50,000-mile class had been used in another city for 25,000 to 30,000 miles, and were then rebuilt at the factory before delivery to the Columbus Transfer Co., in the service of which the additional mileage had been added up to the time of testing. Thus, in all but one class the average results from three cabs are available for use in making comparisons.

DETAILS OF TESTING EQUIPMENT

Fig. 1 is a general view of the testing equipment with a cab in place. The principal items in Fig. 1 are: *A*, weight and scale; *B*, bellcrank and stand; *C*, drawbar; *D*, 24-in-diameter fan-blower; *E*, 2-cu-ft-capacity gasometer; *F*, fuel stand with scales; *G*, indicating speedometer; *H*, dynamometer controls; *I*, drums; *J*, block-test dynamometer; *K*, 6-in. chain, sprocket ratio 7 to 1; *L*, tie-rods; and *M*, exhaust-gas conduit; exhaust fan is in the pit.

Items *A*, *B* and *C* are shown a little more in detail in Fig. 2, in which can be seen the general proportions of the parts which are designated by lower-case italic reference letters; the handwheels, *n*; the dash-pot, *o*; and the jaw-clamp, *p*, which is fastened to the center of the front axle when making a test. The drawbar was approximately 6 ft. long so that the fan could be mounted in front of the radiator. The dash-pot on this installation was rather small, 3 in. in diameter, so some difficulty was experienced in obtaining readings if the rear wheels of the cab were very eccentric. The traction scale was sufficiently sensitive to show the effect of pushing lightly with one finger on the vehicle. The effect of turning the blower on or off was to change the scale reading by 2 to 2½ lb. The handwheels were used to bring the bellcrank to a given position for all readings, thus giving assurance that the rear wheels were always in the proper position on the drums.

The gasometer was connected through a flexible hose to the crankcase breather so that the leakage past the pistons of the engine might be observed over suitable time intervals. The weight of the bell was carefully balanced so that very little pressure was required within the crankcase to cause it to rise.

The fuel stand and scale were arranged so that gravity feed was available for all tests. The time required for a particular run was taken as the time needed for the consumption of 1 to 2 lb. of fuel and varied from about 5 to 12 min.

The indicating speedometer was an electric tachometer, the magneto for which was driven from the dynamometer shaft. Its readings were used only when making adjustments, a hand-counter being used at the right rear wheel to obtain the actual speed of this part. The mean radius of the wheel was ascertained for use in calculating the vehicle speed. No trouble was encountered from tire slippage in these tests, the passenger compartment of each cab being loaded with 600 lb. during the tests.

The drums of the chassis dynamometer were 48 in. in diameter and so placed in the pit that their tops were on a

[1] M.S.A.E.—Associate professor of automotive engineering, Purdue University, West Lafayette, Ind.

[2] See THE JOURNAL, July, 1927, p. 13.

level with the laboratory floor. The 6-in. Link-Belt chain was arranged to drive the block-test dynamometer through 7-to-1 sprockets, permitting a maximum vehicle speed of 40 m.p.h. without overspeeding the dynamometer. The tie-rods need not be so heavy as those shown, inasmuch as their only duty is to prevent the swaying of the rear end of the vehicle. They should also have been mounted so that they would be horizontal. However, since they were adjusted rather loosely, they had no effect on any readings.

A steel wire, not shown, was stretched directly above the center line of the drum shaft. From this, plumb-bobs were dropped at each side of the cab, so that the rear-axle ends could always be put in proper alignment over the drums.

Consumption, Power and Friction Loads Measured

Each cab was weighed as received from the operating company, so that the loads to be applied to simulate road conditions could be calculated. The frontal area also was determined for use in these same calculations. These loads were determined for 15, 20, 25 and 30 m.p.h.

The cab was then driven up on the chassis dynamometer and carefully aligned so that the rear axle was directly above the center line of the drums, blocks being used at the front wheels to minimize the work of moving the traction-scale parts. With the cab properly located, the drawbar was then attached to the front axle and the bellcrank stand was fastened to the floor by bolts into a T-slot. This stand was so placed that the bellcrank was in the position for reading, a pointer, not shown, being provided to show when the horizontal leg was level.

The gasoline line was then opened and connection was made to the bottle on the fuel stand. The right rear hub-cap was removed. The accelerator was disconnected and an adjustable throttle rod substituted. This new throttle rod could, of course, be locked in any desired position. It was found absolutely necessary to apply a tension spring at the throttle lever that would prevent flutter, as the play between the lever and the connection was sufficient to prevent accurate steady adjustments. The radiator filler-cap and the hood were removed. The gasometer was connected into the crankcase breather. The fan was put in operation in front of the car.

Then, while the engine was warming up, the tare weight of the traction scale was determined after moving the blocks from the front wheels. It was considered as the mean of the readings when the dynamometer was operated to turn the car wheels in the forward and then in the backward directions. Several sets of readings were taken at indicated speeds of

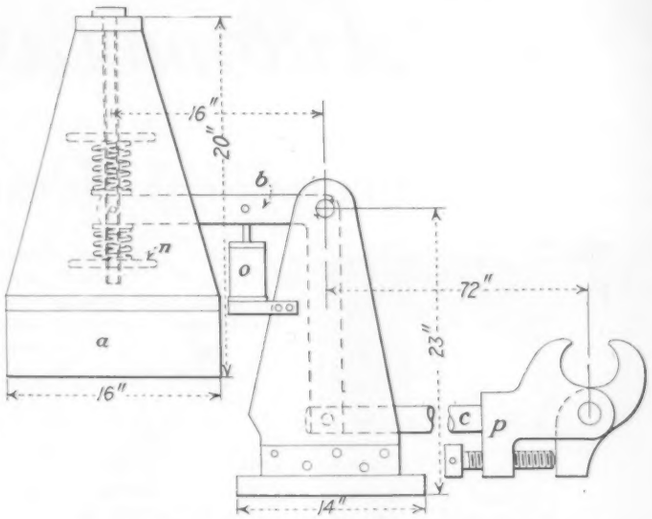


Fig. 2—Diagrammatic View of Traction Scale

Reference Letters Corresponding to Those In Fig. 1 Indicate the Weight and Scale, the Bellcrank and Stand, and the Drawbar. The Hand-Wheel *n* Was Used To Turn the Bellcrank *b* to a Given Position for All Readings, Thus Bringing the Wheels to the Proper Position on the Drum. The Small Size of the Dashpot *o*, 3 In. in Diameter, Occasioned Some Difficulty in Obtaining Readings if the Rear Wheels of the Vehicle Were Very Eccentric. The Jaw-Clamp *p* Was Fastened to the Center of the Front Axle of the Car Being Tested

15 and 25 m.p.h. The reading for either direction included rear-tire, rear-axle and drive-shaft friction added to or subtracted from the actual weight of the traction scale plus or minus small amounts caused by slight inaccuracies in locating the rear wheels on the drums. Larger drums would, of course, lessen the amounts due to such errors. Knowing the tare weight, the load to be applied for any particular speed could easily be set off on the scales, and the throttle and dynamometer load adjusted to balance such scale reading at the corresponding road speed.

A fuel-consumption test run was then made, followed by friction test runs on the various parts of the vehicle; the first including the engine, gearset, drive-shaft, and axle; the second without the engine friction load; and the third without the gearset friction load, the control lever being in the neutral

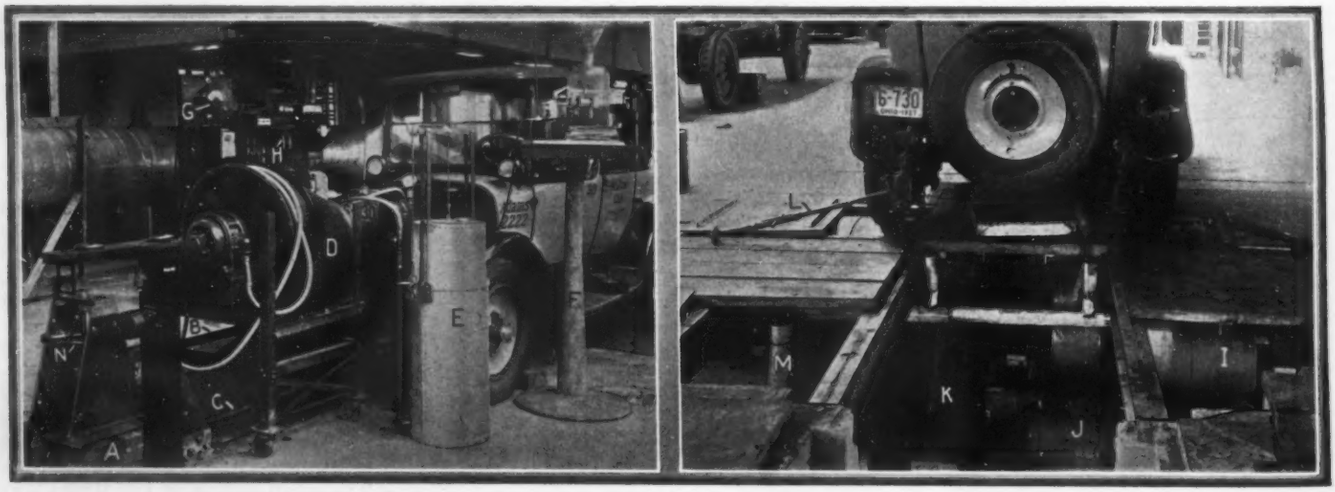


Fig. 1—Engine and Chassis-Testing Equipment at Ohio State University Shown with Vehicle in Place

In the Front View at the Left the Following Items Are Shown: *A*, Weight and Scale; *B*, Bellcrank and Stand; *C*, Drawbar; *D*, 24-In-Diameter Fan-Blower; *E*, Gasometer, 2-Cu-Ft. Capacity; *F*, Fuel Stand with Scales; *G*, Indicating Speedometer; *H*, Dynamometer Controls. Only Part of the Mechanism below the Floor Level Is Included in the Rear View at the Right, Which Shows the Following Apparatus; *I*, Drums; *J*, Block-Test Dynamometer; *K*, 6-In. Chain, Sprocket Ratio 7 to 1; *L*, Tie-Rods; *M*, Exhaust-Gas Conduit. The Exhaust Fan Is in the Pit. This Apparatus Measured Fuel Consumption, Power and Friction Loads at Various Speeds

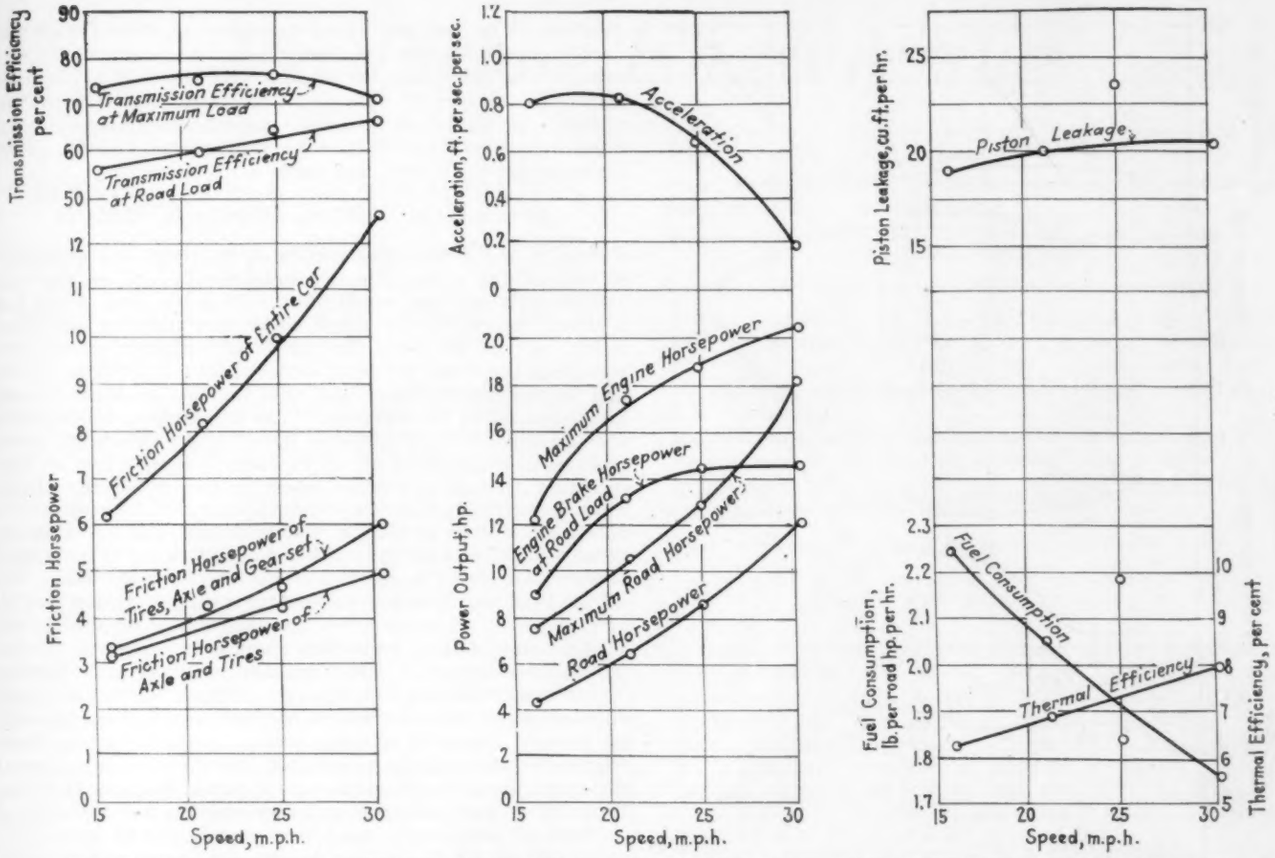


FIG. 3—PERFORMANCE CURVES FOR ONLY CAB IN 140,000-MILE CLASS THAT COULD PULL ITS 30-M.P.H. LOAD

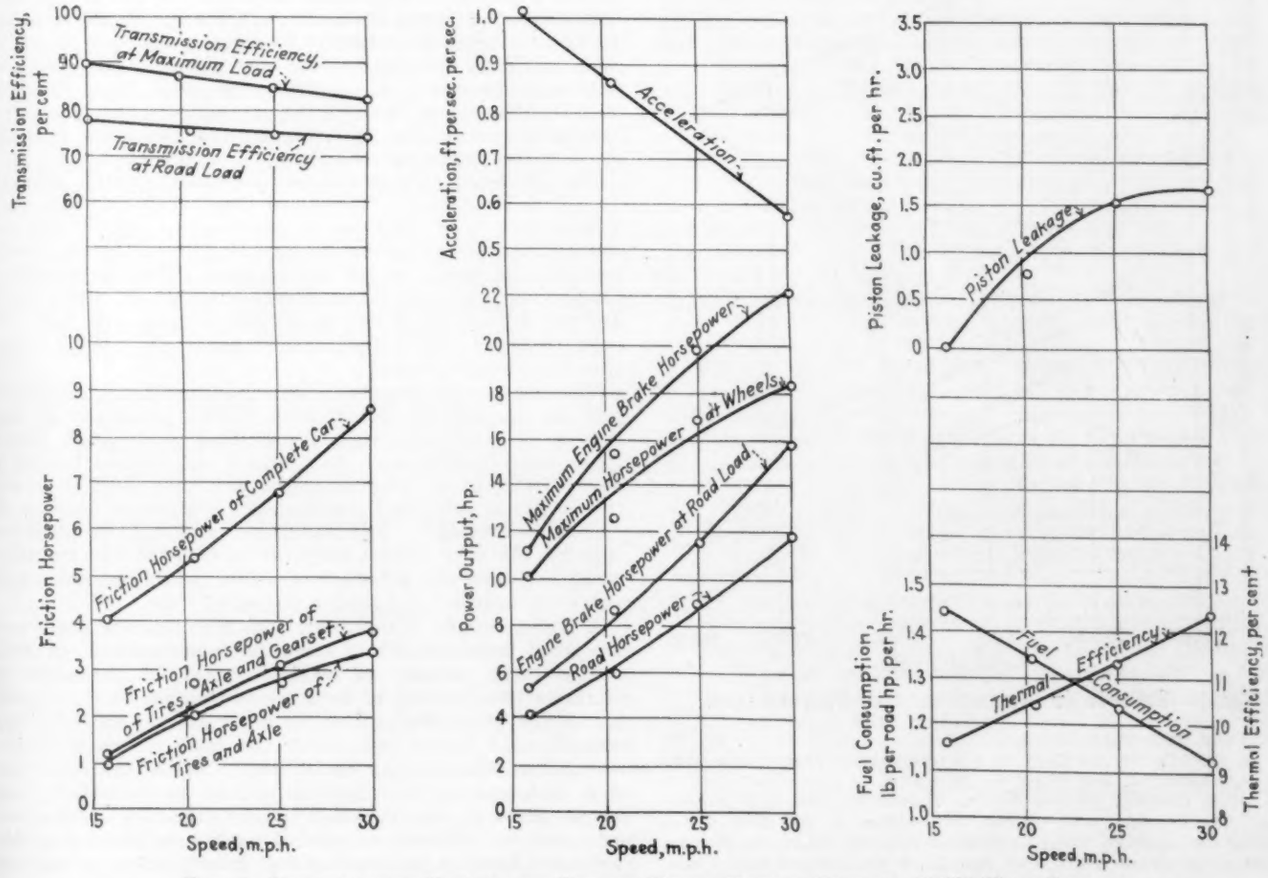


FIG. 4—PERFORMANCE CURVES FOR ONE OF THREE TESTED CABS IN 40,000-MILE CLASS

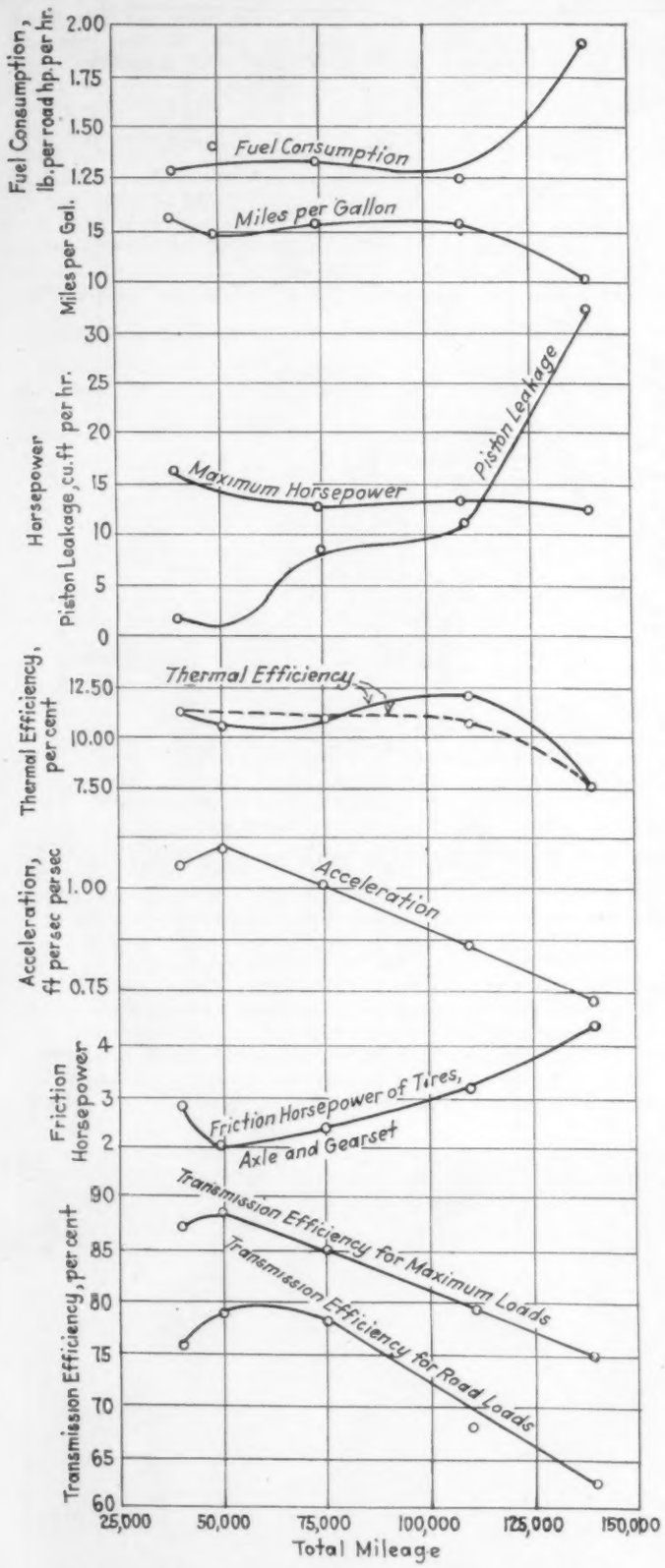


FIG. 5—EFFECTS OF MILEAGE ON CAB PERFORMANCE

Each Point Represents Average Values, at Speeds of 15, 20, 25, and 30 M.P.H., for All Cars in a Particular Mileage Class. The Cars Are Grouped, According to Estimated Mileage Travelled, in Five Such Classes: 40,000, 50,000, 75,000, 110,000, and 140,000 Miles. The Dotted Curve, Plotted in Addition to the Solid Curve Showing the Average Thermal Efficiency of the Complete Vehicle, Indicates the Trend When Cab No. 53 in the 110,000-Mile Class, Which Seems to be Exceptional, Is Omitted

position. The load and speed were then adjusted for another fuel-consumption run and the whole process repeated. Certain of the older cabs would not pull their 30-m.p.h. load. After finishing with the road-load tests, the throttle was opened wide and short runs were made to determine the maximum power of the vehicles at the several speeds. Fuel-consumption tests were not made at these loads.

AVERAGE AND TYPICAL INDIVIDUAL RESULTS

Figs. 3 and 4 show the results as observed and calculated on two of the cabs. Fig. 3 shows the results on the only 140,000-mile cab that would pull its 30-m.p.h. load, while Fig. 5 shows the results for a cab which had traveled but 40,000 miles. It will be noted that the road horsepower was substantially the same for both vehicles, that the friction losses had become much greater, and that the maximum horsepower had decreased in the older cab. The efficiency of transmission was lower by 10 to 15 points in the older cab, while the piston leakage had increased about 10 times. Since the fuel consumption depends to a large extent on the carbureter adjustment, accurate comparisons cannot be made. However, the difference of 0.80 to 0.63 lb. required per road hp-hr. is too great to be accounted for on this score alone. The calculated acceleration shows a great decrease in the older cab.

Fig. 5 shows curves representing average values for all cabs tested in all classes, for all speeds, plotted against the total mileage of their respective classes. It will be noted that the fuel-consumption, piston-leakage and thermal-efficiency curves show rather abrupt changes at the 110,000-mile mark, while all other curves show more gradual changes. Possibly the greatly increased average piston leakage for the three older cabs was entirely responsible for the lessened thermal efficiency. It seems probable that a piston leakage of 10 cu. ft. per hr. is permissible at ordinary road-loads for the 3¾ x 5⅛ four-cylinder engine used in these cabs, while an average leakage of 30 cu. ft. per hr. lowers the power and economy rather noticeably.

The average maximum horsepower over the entire speed range tested dropped from about 16 for the 40,000-mile class to about 12 for the 140,000-mile class, a decrease of 25 per cent, while the average friction horsepower of the rear tires, axle and gearset, in direct drive, increased from about 2.2 to 4.4. This means that, on the average, six less horsepower was available at the road for moving the older than for moving the newer vehicles.

The efficiency of transmission decreased greatly, dropping 15 points between the 75,000 and the 140,000-mile classes at road loads. The reduction in accelerative ability also was great, the average figures being 1.05 ft./sec.^{2} for the newer and 0.72 ft./sec.^{2} for the oldest class. This represents a drop of 32 per cent in accelerative ability in direct drive. Drivers are forced to use second speed more with the older cabs, probably with a further increase in the fuel consumption in average service.

These tests show clearly the effects of mechanical deterioration on the vehicle performance. While it might be said that not enough cabs were tested, that not enough vehicle types were covered, and that certain other items having to do with the service records might well have been examined, the results as presented constitute an addition of facts to our present knowledge. Additional material can be procured only by the very closest cooperation between the manufacturer, the user, and some organization capable of doing such test work over a considerable period of time.

A true scientific examination into maintenance must meet the usual requirements of scientific investigation: A sufficiently large number of vehicles must be assembled to eliminate the drawing of conclusions that may be erroneous due to the preponderance of weight given to an individual example used in the tests. For the same reason a variety of types of vehicle must be included. While the conditions of a maintenance investigation cannot be controlled, they can be more or less definitely known, through service records, and the influence of variations in conditions thus discounted. Such a thorough-going investigation would aid not only maintenance but design.—H. M. Jacklin.

Production Engineering

PROPOSED GAGE STANDARDIZATION

Independent Committee Developing Standards for Plug, Thread and Ring Gages

With the original purpose of standardizing gages as an aid to their prompt and economical procurement in times of military emergency, a meeting was called about a year ago by Col. J. O. Johnson, chief of the gage section, Ordnance Department, United States Army. The resulting informally organized committee broadly represents manufacturers and industrial users of gages and it is believed that this work may be of value to industry in general as well as to the Ordnance Department. Accordingly, the American Engineering Standards Committee, of which the Society is a member; the National Screw Thread Commission, on which also the Society is represented; and the Federal Specification Board have been asked to recognize this committee and adopt the standards it develops.

Plug gages, thread gages and ring gages have been the subjects considered by the committee, which has confined its attention to the design of the blanks, leaving the details of the gaging surfaces to the individual manufacturers and purchasers.

The work on plain and threaded plug gages and ring gages, covering a range from ¼ to 1½ in., has been nearly completed. Standards for sizes below ¼ in. and also from 1½ to 4½ in. are now being considered.

Several meetings have been held for the consideration of these standards. These meetings have been attended by two or three representatives of the Ordnance Department besides Colonel Johnson, and by two representatives of the Bureau of Standards. Manufacturers of tools have been represented by 18 individuals from 10 different companies. Seven automobile manufacturing companies have sent 13 different men and five electrical manufacturers have sent 11 men to one or more of the meetings. Others attending the meetings included four consulting engineers, two representatives of the American Engineering Standards Committee and one representative of a National engineering society.

Among these men a subcommittee was organized, with D. W. Ovaitt, of the General Motors Corporation, as chairman, and H. W. Bearce, of the Bureau of Standards, as secretary. Other members of the subcommittee represent five different tool manufacturers, one automobile manufacturer and two large electrical manufacturers, and two are consulting engineers.

When the recommended details of the gages from ¼ to 1½ in. are agreed upon, they will be printed in THE JOURNAL. The next meeting of the committee will be held at the Engineering Societies Building in New York City, Dec. 5.

BIBLIOGRAPHY OF PRODUCTION PAPERS

List of Articles in THE JOURNAL Which Are of Interest to Production Men

Many papers of interest to production men have been presented from time to time at the various National and Section Meetings of the Society, and some additional material of the sort has been printed in THE JOURNAL.

The Research Department of the Society has prepared the following list of such papers and articles, to make them more easily found in files of THE JOURNAL for past years that are available in the libraries and engineering departments of many automotive concerns. The articles are grouped according to their main subjects, and papers in the various groups are arranged chronologically so that the more recent papers can be distinguished readily. No attempt has been made at cross-indexing.

FACTORY EQUIPMENT

Conveyors

The Application of Conveyor Equipment to a Small Production Plant; by H. P. Harrison. THE JOURNAL, November, 1923, p. 357; and December, 1923, p. 479. Reprinted in TRANSACTIONS, Vol. 18, Part II, p. 614.

Conveyors Used in the Automotive Industry; by C. A. Brock. THE JOURNAL, October, 1926, p. 343.

Transportation by Conveyor; by Paul Phelps and N. H. Preble. THE JOURNAL, October, 1926, p. 413.

Machine-Tools, Tools and Fixtures

The Control of Operating Tool and Supply Cost; by F. A. Mance. THE JOURNAL, November, 1922, p. 407.

Standard versus Special Machine-Tools for Automotive Production; by R. K. Mitchell. THE JOURNAL, December, 1922, p. 472.

Selection of Machine-Tools; by A. J. Baker. THE JOURNAL, December, 1922, p. 520. Reprinted in TRANSACTIONS, Vol. 17, Part II, p. 682.

Some Suggestions for Builders and Users of Machine-Tools; by Thomas Nadin. THE JOURNAL, February, 1924, p. 134; and June, 1924, p. 614.

Tool Designing for Production Manufacturing; by P. V. Miller. THE JOURNAL, November, 1924, p. 445; and May, 1925, p. 513.

The Economic Aspect of Tooling for Interchangeable Production; by Joseph Lannen. THE JOURNAL, January, 1925, p. 59; and February, 1925, p. 225. Reprinted in TRANSACTIONS, Vol. 19, Part II, p. 503.

Tool Salvage; by L. A. Churgay. THE JOURNAL, November, 1924, p. 456; and April, 1925, p. 458.

Applying Jigs and Fixtures to Engine-Block Machining; by J. G. Moohl. THE JOURNAL, October, 1925, p. 323.

Machine-Tool Needs of the Automotive Industry; by R. M. Hidey. THE JOURNAL, October, 1925, p. 359; and March, 1926, p. 316.

An Analysis of Machine-Tool Maintenance; by A. R. Kelso. THE JOURNAL, October, 1925, p. 385; and March, 1926, p. 320.

Making Machine-Tools Safe; by R. F. Thalner. THE JOURNAL, November, 1925, p. 479; and May, 1926, p. 521.

How To Select Machine-Tools; by W. G. Careins. THE JOURNAL, March, 1926, p. 275.

Fitting the Machine-Tool to the Job; by O. C. Kavle. THE JOURNAL, October, 1926, p. 399.

Machine-Tool Failures—Their Causes and Avoidance; by E. R. Stoddard. THE JOURNAL, March, 1927, p. 385.

Application of Electric Motors to Machine-Tools; by R. C. Deale. THE JOURNAL, October, 1927, p. 383.

Net Profit from Modern Machine-Tools; by George T. Trundle, Jr. THE JOURNAL, November, 1927, p. 532.

Tool Standardization; by F. W. Stein. THE JOURNAL, November, 1927, p. 576.

Miscellaneous Equipment

Factory Lighting; THE JOURNAL, November, 1918, p. 336.

Maintenance Practice at the Ford Plant; by E. E. Remington. THE JOURNAL, January, 1925, p. 82; and May, 1925, p. 527.

MATERIALS

Aluminum and Aluminum Alloys

Decreasing Unsprung Weight by the Use of Aluminum; by A. H. Edgerton. THE JOURNAL, January, 1920, p. 26. Reprinted in TRANSACTIONS, Vol. 15, Part I, p. 688.

The Use of Aluminum in the Present and the Future Motor-Car; by Ferdinand Jehle. THE JOURNAL, June, 1920, p. 367. Reprinted in TRANSACTIONS, Vol. 15, Part I, p. 885.

Developments in Alloyed Aluminum; by R. E. Carpenter. THE JOURNAL, July, 1920, p. 86.

Aluminum Alloys; by Zay Jeffries. THE JOURNAL, September, 1920, p. 295. Reprinted in TRANSACTIONS, Vol. 15, Part II, p. 438.

Duralumin; THE JOURNAL, October, 1920, p. 359.

Duralumin; by R. W. Daniels. THE JOURNAL, December, 1922, p. 477. Reprinted in TRANSACTIONS, Vol. 17, Part II, p. 751.

Notes on a Sand-Cast Aluminum-Copper-Nickel-Magnesium Alloy; by Lieut. A. J. Lyon and Samuel Daniels. THE JOURNAL, February, 1924, p. 173; and April, 1924, p. 431. Reprinted in TRANSACTIONS, Vol. 19, Part I, p. 485.

Ferrous Metals

Treatment and Selection of Steel; by John F. Keller. THE JOURNAL, August, 1917, p. 147; and September, 1917, p. 188.

The Relative Corrosion of Alloys; by R. B. Fehr. THE JOURNAL, January, 1919, p. 42.

The Electrical Heat-Treatment of Steel; by H. P. MacDonald. THE JOURNAL, July, 1919, p. 69. Reprinted in TRANSACTIONS, Vol. 14, Part II, p. 335.

Steels for Automotive Gears; by J. Heber Parker. THE JOURNAL, July, 1919, p. 75.

High-Chromium Steel for Exhaust Valves; THE JOURNAL, September, 1919, p. 262.

Hot Deformation and the Quality of Steel; by Georges Charpy. THE JOURNAL, October, 1919, p. 288.

Acid Bessemer Process; by R. S. McCaffery. THE JOURNAL, October, 1919, p. 329.

The Essentials of High-Grade Steel Manufacture; by W. R. Shimer. THE JOURNAL, June, 1920, p. 387. Reprinted in TRANSACTIONS, Vol. 15, Part I, p. 922.

The Heat-Treatment of a High-Chromium Steel; by H. J. French and Yoshito Yamauchi. THE JOURNAL, July, 1920, p. 103.

The Most Suitable Steels for Automobile Parts; by Dr. W. H. Hatfield. THE JOURNAL, October, 1920, p. 327.

Stellite and Stainless Steel; by Elwood Haynes. THE JOURNAL, October, 1920, p. 349.

Chrome-Molybdenum-Steel Applications from the Consumer's Viewpoint; by C. N. Dawe. THE JOURNAL, January, 1922, p. 47. Reprinted in TRANSACTIONS, Vol. 17, Part I, p. 673.

Pertinent Facts Concerning Malleable-Iron Castings; by Enrique Touceda. THE JOURNAL, January, 1922, p. 53; and May, 1922, p. 375. Reprinted in TRANSACTIONS, Vol. 17, Part I, p. 632.

Use of Molybdenum Steel in the Automotive Industry; by John D. Cutter. THE JOURNAL, May, 1922, p. 340.

Automobile Design and Automotive Steels; by Thomas H. Wickenden. THE JOURNAL, May, 1925, p. 538.

Cast Iron in Its Relation to the Automotive Industry; by E. J. Lowry. THE JOURNAL, February, 1927, p. 277.

Woods

Plywood and Its Uses in Automobile Construction; by Armin Elmendorf. THE JOURNAL, May, 1920, p. 299; and October, 1920, p. 390. Reprinted in TRANSACTIONS, Vol. 15, Part I, p. 863.

Substitutes for Ash in Automobile Bodies; THE JOURNAL, September, 1921, p. 181.

The Needless Hardwood Lumber Waste; by Frederick F. Murray. THE JOURNAL, January, 1923, p. 95; and May, 1923, p. 455.

Wood for Automobile Bodies; by Arthur T. Upson and Leyden N. Ericksen. THE JOURNAL, February, 1924, p. 165. Reprinted in TRANSACTIONS, Vol. 19, Part I, p. 513.

Miscellaneous Materials

Fabricated Bakelite Materials; by Ray P. Jackson. THE JOURNAL, October, 1917, p. 256.

Worm Gear Bronzes; by W. M. Corse. THE JOURNAL, April, 1918, p. 267. Reprinted in TRANSACTIONS, Vol. 13, Part I, p. 234.

Cotton Fabric for Airplanes; THE JOURNAL, October, 1918, p. 290.

Properties of Airplane Fabrics; by E. Dean Walen. THE JOURNAL, June, 1919, p. 526.

High-Temperature Properties of White-Metal Bearing Alloys; by John R. Freeman, Jr., and R. W. Woodward. THE JOURNAL, February, 1921, p. 149.

Casein Glues for Automobile-Body Assembly; by W. A. Henderson. THE JOURNAL, February, 1924, p. 186; and October, 1924, p. 301.

Trimming Materials and Style; by H. T. Strong. THE JOURNAL, April, 1924, p. 438; and October, 1924, p. 302.

The Significance of Common Physical Properties of Structural Materials; by F. H. Moore. THE JOURNAL, August, 1925, p. 175.

Chromium—Its Properties and Uses; by Colin G. Fink. THE JOURNAL, January, 1927, p. 157.

Rubber as a Material for Mechanical Engineering; by W. A. Gibbons. THE JOURNAL, September, 1927, p. 262.

Cellulose-Nitrate Coated Fabrics; by E. H. Nollau. THE JOURNAL, October, 1927, p. 393.

Manufacturing and Testing Rubber-Coated Automobile Fabrics; by M. N. Nickowitz. THE JOURNAL, October, 1927, p. 396.

ORGANIZATION

Notes on Works Organization; by A. W. Reeves and Cecil Kimbler. THE JOURNAL, July, 1917, p. 77.

Efficiency in Factory Reproduction; by Francis A. Carlisle. THE JOURNAL, March, 1918, p. 220.

Conditions in the Automotive Industry Abroad; by David Beecroft. THE JOURNAL, June, 1919, p. 521. Reprinted in TRANSACTIONS, Vol. 14, Part I, p. 669.

Scrap Organization and Scrap Salvaging; by Lieut. Charles A. Reagan. THE JOURNAL, January, 1919, p. 47.

Flexibility in Organization; by John Younger. THE JOURNAL, April, 1920, p. 237. Reprinted in TRANSACTIONS, Vol. 15, Part I, p. 857.

Shop Production-Control and Accounting Systems; by A. G. Drefs. THE JOURNAL, July, 1920, p. 33. Reprinted in TRANSACTIONS, Vol. 15, Part II, p. 101.

Decreasing Production Costs through Standardization; by W. D. Pardoe. THE JOURNAL, December, 1921, p. 379.

Utilization and Prevention of Waste; by C. B. Auel. THE JOURNAL, November, 1924, p. 407; and February, 1925, p. 223.

Possible Economies in Automotive Machine-Shop Operation; by A. L. DeLeeuw. THE JOURNAL, November, 1924, p. 418; and April, 1925, p. 460. Reprinted in TRANSACTIONS, Vol. 19, Part II, p. 469.

Organizing for Plant Maintenance Work; by L. A. Blackburn. THE JOURNAL, November, 1924, p. 440; and May, 1925, p. 527.

Industrial Standardization; by F. I. Rhodes. THE Journal, March, 1925, p. 379.

Needed Relations between Service Station and Factory; by A. E. Hutt. THE JOURNAL, August, 1926, p. 167.
Integrated Production; by E. P. Blanchard. THE JOURNAL, October, 1927, p. 375.

PERSONNEL

Engineers and Executives

The Engineer in Industry; by Edward A. Deeds. THE JOURNAL, October, 1920, p. 331.
Engineers and Production Managers; by Charles S. Dahlquist. THE JOURNAL, October, 1923, p. 310.
The Brains of Production; by C. B. Gordy. THE JOURNAL, June, 1925, p. 604.
The Training of Future Executives; by John Younger. THE JOURNAL, May, 1926, p. 479; and February, 1927, p. 259.
The Automotive Industry as a Field for Young Engineers; by David Beecroft. THE JOURNAL, May, 1927, p. 589.
How To Become an Executive; by John Younger. THE JOURNAL, May, 1927, p. 597.
Teaching Production Principles to Engineering Students; by Myron A. Lee. THE JOURNAL, August, 1927, p. 193.

Wage-Payment Plans

The Group Bonus Wage-Incentive Plan; by E. Karl Wennerlund. THE JOURNAL, November, 1922, p. 402; and January, 1923, p. 27. Reprinted in TRANSACTIONS, Vol. 17, Part II, p. 763.
Wage-Incentive Systems; by Eugene Bouton. THE JOURNAL, November, 1923, p. 380; and December, 1923, p. 480.
Group Wage-Payment Plan; by H. G. Perkins. THE JOURNAL, November, 1924, p. 464; and May, 1925, p. 516.
The Application of Group Bonus to Non-Productive Labor; by Joseph Lannen. THE JOURNAL, August, 1926, p. 145.

Miscellaneous Personnel

Man-Power of the Future; by Harry Tipper. THE JOURNAL, August, 1918, p. 164.
A Constructive Labor Program; by T. N. Carver. THE JOURNAL, August, 1919, p. 155.
The Human Element in Production; by A. F. Knobloch. THE JOURNAL, August, 1920, p. 137.
Interdepartmental Production Contests; by R. R. Potter. THE JOURNAL, September, 1920, p. 258.
The Production Man's Place in Our Industry; by A. B. C. Hardy. THE JOURNAL, December, 1922, p. 561.
The Human Element in Production; by W. F. Jameson. THE JOURNAL, November, 1923, p. 366; and December, 1923, p. 478.
Training Employes in Production Work; by Lillian M. Gilbreth. THE JOURNAL, October, 1925, p. 399; and January, 1926, p. 53.
Training the Foremen of a Manufacturing Organization; by Louis Ruthenberg. THE JOURNAL, October, 1925, p. 350; and January, 1926, p. 54.
Foremen's Conferences, Products and By-Products of; by Franklin T. Jones. THE JOURNAL, January, 1926, p. 60; and March, 1926, p. 326.
A Comprehensive Apprenticeship Program for the Automotive Industry; by H. A. Frommelt. THE JOURNAL, April, 1927, p. 443.
Time Study in Its Relation to Labor Budget; by E. J. Frounfelker. THE JOURNAL, October, 1927, p. 386; and November, 1927, p. 548.

PROCESSES AND PRODUCTS

Aircraft

Final Tests of U. S. Aviation Engines; THE JOURNAL, September, 1917, p. 177.
Conventional Propeller Calculations; by F. W. Caldwell. THE JOURNAL, August, 1918, p. 132. Reprinted in TRANSACTIONS, Vol. 13, Part II, p. 307.
Aircraft War Activities of Forest Products Laboratory; by C. H. Teesdale. THE JOURNAL, May, 1919, p. 412.
The Construction of the Navy-Curtiss Flying Boats; THE JOURNAL, June, 1919, p. 439.
Optical Determination of Stresses in Airplane Spars; THE JOURNAL, October, 1920, p. 393.
Non-Injurious Ultimate-Strength Tests for Interplane Struts; by E. R. Maurer. THE JOURNAL, September, 1921, p. 201.
A Method of Developing Aircraft Engines; by G. E. A. Hallett. THE JOURNAL, June, 1922, p. 457. Reprinted in TRANSACTIONS, Vol. 17, Part II, p. 787.
The Modern Airplane and All-Metal Construction; by W. B. Stout. THE JOURNAL, December, 1922, p. 495.
Military-Airplane Development and Construction in Peace-time; by F. H. Russell. THE JOURNAL, March, 1923, p. 296; and April, 1923, p. 361.
Metal Airplanes; by W. B. Stout. THE JOURNAL, February, 1925, p. 209.
Economical Production of All-Metal Airplanes and Seaplanes; by Adolph Rohrbach. THE JOURNAL, January, 1927, p. 57.
The Wright Whirlwind Engine Production Methods; by Lee M. Beatty. THE JOURNAL, October, 1927, p. 361.
Metal Construction of Aircraft; by Commander R. D. Weyerbacher, U.S.N. THE JOURNAL, November, 1927, p. 489.
Selection of Materials for Aircraft Structures; by J. A. Roche. THE JOURNAL, November, 1927, p. 494.

Bodies

Automobile Body Construction; by P. E. Stone. THE JOURNAL, May, 1921, p. 404. Reprinted in TRANSACTIONS, Vol. 16, Part I, p. 785.
Commercial-Body Supply and Service; by C. M. Manly and C. B. Veal. THE JOURNAL, March, 1922, p. 179. Reprinted in TRANSACTIONS, Vol. 17, Part I, p. 781.
Cheaper Closed Body Construction; by George J. Mercer. THE JOURNAL, February, 1923, p. 213; and May, 1923, p. 450. Reprinted in TRANSACTIONS, Vol. 18, Part I, p. 426.
Taxicab Body Construction; by Hugh G. Bersie. THE JOURNAL, May, 1923, p. 480. Reprinted in TRANSACTIONS, Vol. 18, Part I, p. 454.
The Weymann Silent Flexible Body; by George W. Kerr. THE JOURNAL, February, 1925, p. 215.
Building of All-Steel Vehicle Bodies; by Edward G. Budd and J. Ledwinka. THE JOURNAL, February, 1925, p. 219.

Casting, Forging and Pressing

Continuous Die Rolling; by G. R. Norton. THE JOURNAL, January, 1922, p. 43.
Hot-Swaging of Rear-Axle Shafts; by R. A. DeVlieg. THE JOURNAL, May, 1924, p. 507; and July, 1924, p. 107.
Coining-Press Operation; by A. R. Kelso. THE JOURNAL, November, 1924, p. 399; and May, 1925, p. 510. Reprinted in TRANSACTIONS, Vol. 19, Part II, p. 516.
Die-Castings Made of Non-Ferrous Metals; by Marc Stern. THE JOURNAL, September, 1925, p. 254.
Hot Stampings and Their Production; by G. F. Keyes. THE JOURNAL, November, 1925, p. 452; and January, 1926, p. 57.

Finishes and Plating

Artificial versus Natural Means of Drying Paint and Varnish; by R. E. Lippert. THE JOURNAL, Novem-

ber, 1921, p. 335. Reprinted in TRANSACTIONS, Vol. 16, Part II, p. 458.

Manufacture and Application of Automobile Varnishes and Paints; by L. Valentine Pulsifer. THE JOURNAL, January, 1922, p. 12; and May, 1922, p. 388. Reprinted in TRANSACTIONS, Vol. 17, Part I, p. 695.

Paint Protection for Wood; by Cornelius T. Myers. THE JOURNAL, May, 1922, p. 348.

Automobile Finishing-Varnish; by L. Valentine Pulsifer. THE JOURNAL, January, 1923, p. 89; and May, 1923, p. 456. Reprinted in TRANSACTIONS, Vol. 18, Part I, p. 466.

Painting Practice from the Chemist's Viewpoint; by L. Valentine Pulsifer. THE JOURNAL, April, 1923, p. 335.

Process of and Equipment for Fender and Body Enameling; by Gordon Lefebvre. THE JOURNAL, February, 1924, p. 195; and June, 1924, p. 612.

Rust Resistance of Nickel-Plated Steel; by Edwin M. Baker. THE JOURNAL, February, 1924, p. 127; and October, 1924, p. 300. Reprinted in TRANSACTIONS, Vol. 19, Part I, p. 466.

Causes of Surface Checks in Wood in Varnish-Drying Rooms; by Harry D. Tiemann. THE JOURNAL, November, 1924, p. 431; and May, 1925, p. 523. Reprinted in TRANSACTIONS, Vol. 19, Part II, p. 565.

Durability of Plated Surfaces; by W. M. Phillips. THE JOURNAL, November, 1924, p. 461; and January, 1925, p. 73.

Improved Nickel-Plating Methods; by W. H. Graves. THE JOURNAL, January, 1925, p. 86. Reprinted in TRANSACTIONS, Vol. 19, Part II, p. 548.

Finish Failures Overcome with Pyroxylin Enamel; by H. C. Mougey. THE JOURNAL, August, 1925, p. 183.

Pyroxylin Refinishing-Practice; by J. J. Riley. THE JOURNAL, September, 1925, p. 245.

Purposes, Methods and Results of Chromium-Plating; by W. N. Phillips. THE JOURNAL, February, 1927, p. 255.

Gears

Methods of Gear Design and Gear-Cutting; by Glenn Muffly. THE JOURNAL, October, 1921, p. 219.

Rear-Axle Gear Calculations by the Compressive-Stress Method; by Joseph Jandasek. THE JOURNAL, October, 1922, p. 375.

Gear Grinding; by R. S. Drummond. THE JOURNAL, February, 1923, p. 174. Reprinted in TRANSACTIONS, Vol. 18, Part I, p. 558.

Hobbing-Machine Operation; by John Edgar. THE JOURNAL, February, 1923, p. 179.

How To Use Gear-Cutting Hobs; by S. C. Bjornberg. THE JOURNAL, February, 1923, p. 181. Reprinted in TRANSACTIONS, Vol. 18, Part I, p. 613.

Gear Grinding and Tooth Forms; by Glenn Muffly. THE JOURNAL, June, 1923, p. 545. Reprinted in TRANSACTIONS, Vol. 18, Part I, p. 568.

Spur-Gear Grinding and Testing; by A. J. Ott and C. L. Ott. THE JOURNAL, November, 1923, p. 401; and December, 1923, p. 473. Reprinted in TRANSACTIONS, Vol. 18, Part II, p. 579.

Some Sidelights on the Gear Problem; by W. R. Griswold. THE JOURNAL, May, 1924, p. 545.

The Need of Grinding Carburized and Hardened Gears; by O. H. Schafer. THE JOURNAL, May, 1924, p. 548. Reprinted in TRANSACTIONS, Vol. 19, Part I, p. 404.

Oil-Treated Steel and Ground Gears; by L. A. Danse. THE JOURNAL, May, 1924, p. 551. Reprinted in TRANSACTIONS, Vol. 19, Part I, p. 411.

The Polishing and Burnishing of Gear Teeth; by R. E. Linn. THE JOURNAL, May, 1924, p. 554.

Importance of Accuracy of Tooth-Form; by A. H. Frauenthal. THE JOURNAL, May, 1924. p. 556.

The Problem of Gear Production; by Earle Buckingham. THE JOURNAL, October, 1925, p. 325; and March, 1926, p. 315.

Coordinating Gear Design and Production Methods; by Perry L. Tenney. THE JOURNAL, October, 1925, p. 372.

Design, Production and Application of the Hypoid Rear-Axle Gear; by Arthur L. Stewart and Ernest Wildhaber. THE JOURNAL, June, 1926, p. 575.

Gear Steels and the Production of Automobile Gears; by John Bethune and W. G. Hildorf. THE JOURNAL, October, 1926, p. 422.

Production of Automobile Gears; by C. L. Cameron. THE JOURNAL, November, 1926, p. 475.

Inspection and Testing

Factory Inspection; by Walter C. Keys. THE JOURNAL, October, 1918, p. 266.

The Measurement of Gages. THE JOURNAL, October, 1919, p. 314.

Tautometer for Testing Doped Surfaces. THE JOURNAL, October, 1919, p. 335.

Location of Flaws in Rifle-Barrel Steel by Magnetic Analysis; by R. L. Sanford and W. B. Kouwenhoven. THE JOURNAL, February, 1920, p. 84.

Inspection and Testing in Interchangeable Manufacture; by Earle Buckingham. THE JOURNAL, January, 1921, p. 57.

The Relation of Recoverance to the Fatigue of Metals; by Robert G. Guthrie. THE JOURNAL, January, 1921, p. 65.

Developing a Method for Testing Brake-Linings; by S. von Ammon. THE JOURNAL, March, 1922, p. 153. Reprinted in TRANSACTIONS, Vol. 17, Part I, p. 478.

The Sauer Bevel-Gear Testing Machine. THE JOURNAL, August, 1922, p. 193.

Testing Leather Substitutes and Top Material; by J. B. Davis. THE JOURNAL, March, 1923, p. 276.

Testing Materials for Automotive Parts; by R. J. Allen. THE JOURNAL, July, 1923, p. 39.

The Testing of Materials and Its Effect on Engineering; by G. B. Upton. THE JOURNAL, October, 1923, p. 296.

Factors Governing "Out-of-Roundness" Measurement; by A. H. Frauenthal. THE JOURNAL, November, 1923, p. 370; and December, 1923, p. 484. Reprinted in TRANSACTIONS, Vol. 18, Part II, p. 600.

The Standardization of Methods of Applying the Scleroscope; by A. F. Shore. THE JOURNAL, November, 1923, p. 409; and December, 1923, p. 483. Reprinted in TRANSACTIONS, Vol. 18, Part II, p. 641.

Systematic Gage-Checking as a Requisite of Precise Measurement; by Joseph Lannen. THE JOURNAL, April, 1924, p. 407; and July, 1924, p. 108.

A Few High Points on the Inspection of Processed Material; by C. S. Stark. THE JOURNAL, August, 1924, p. 156; and November, 1924, p. 437.

Gages, A Key Problem; by G. K. Burgess. THE JOURNAL, April, 1925, p. 456.

Eye-Bolt Stresses as Determined by Photoelastic Test; by Thomas H. Frost and Lieut. Walter E. Richards. THE JOURNAL, August, 1925, p. 213.

The Testing of Sheet Steel; by E. F. Collins. THE JOURNAL, September, 1925, p. 290.

Some Aspects of Airplane Inspection; by J. J. Feeley. THE JOURNAL, November, 1925, p. 441; and May, 1926, p. 523.

Inspection of Knight-Engine Sleeves; by J. B. Scott. THE JOURNAL, October, 1926, p. 351.

Corona Tests of Ignition Cables; by F. L. Haushalter. THE JOURNAL, October, 1926, p. 361.

Inspection along the Line; by A. H. Frauenthal. THE JOURNAL, October, 1926, p. 364; and February, 1927, p. 227.

Methods and Means Used for Small-Gear Inspection; by P. W. Rhame. THE JOURNAL, October, 1926, p. 409.

Two Engine-Casting Inspection Fixtures; by A. R. Fors. THE JOURNAL, October, 1926, p. 370.

Instrument for Measuring Surface Finish by Reflected Light; by C. S. Stark. THE JOURNAL, November, 1926, p. 481.

Applications of X-Rays in the Automotive Industry; by George L. Clark, Robert H. Aborn and Elmer W. Brugmann. THE JOURNAL, February, 1927, p. 291.

Continuation of 1922 Report on Brake-Lining Tests; by S. von Ammon. THE JOURNAL, November, 1927, p. 551.

Machining Processes

Malleable-Iron Drilling Data; by H. A. Schwartz and W. W. Flagle. THE JOURNAL, July, 1922, p. 81. Reprinted in TRANSACTIONS, Vol. 17, Part II, p. 729.

Ford Engine Cylinder Production; by P. E. Haglund and I. B. Scofield. THE JOURNAL, December, 1922, p. 463. Reprinted in TRANSACTIONS, Vol. 17, Part II, p. 703.

Developments in Production Grinding in the Automotive Industry; by Oscar A. Knight. THE JOURNAL, November, 1923, p. 387; and December, 1923, p. 475. Reprinted in TRANSACTIONS, Vol. 18, Part II, p. 554.

Cylinder Bores; Should They Be Honed or Lapped; symposium, by F. N. Thiefels, A. R. Fors, R. A. Davlieg, H. C. Miller, O. E. Hovey, Victor Colliau, Dan Smith and J. G. Hammond. THE JOURNAL, July, 1926, p. 84.

External Cylindrical Honing; by L. A. Becker. THE JOURNAL, October, 1927, p. 377.

Petroleum

Petroleum Refining; by C. W. Stratford. THE JOURNAL, July, 1918, p. 69. Reprinted in TRANSACTIONS, Vol. 13, Part II, p. 267.

Status of Refinery Practice with Regard to Gasoline Production; by Dr. E. W. Dean. THE JOURNAL, May, 1919, p. 372. Reprinted in TRANSACTIONS, Vol. 14, Part I, p. 229.

Petroleum Refining; by R. W. Cunningham. THE JOURNAL, July, 1919, p. 78. Reprinted in TRANSACTIONS, Vol. 14, Part II, p. 429.

The Fuel Problem from the Refiner's Viewpoint; by R. L. Welch. THE JOURNAL, September, 1920, p. 291.

Petroleum Refining Processes and Problems; by H. H. Hill. THE JOURNAL, January, 1921, p. 51.

Cracking Processes in the Petroleum Industry; by Frank A. Howard. THE JOURNAL, May, 1923, p. 510.

Seek Cracking Process for Production of Non-Detonating Fuel; by J. B. Hill and T. G. Delbridge. THE JOURNAL, March, 1926, p. 271.

Production of Gasoline Substitutes from Coal; by A. C. Fieldner. THE JOURNAL, January, 1927, p. 98.

Splined Shafts

Methods of Generating the Involute Spline and Its Application; by Douglas T. Hamilton. THE JOURNAL, August, 1920, p. 149.

Torsonial Strength of Multiple-Splined Shafts; by C. W. Spicer. THE JOURNAL, February, 1921, p. 129. Reprinted in TRANSACTIONS, Vol. 16, Part I, p. 391.

Processing Spline Shafts by a New Method; by J. A. Ford. THE JOURNAL, November, 1922, p. 433. Reprinted in TRANSACTIONS, Vol. 17, Part II, p. 698.

Torsonial Strength of Multiple-Splined Shafts; by C. W. Spicer. THE JOURNAL, June, 1927, p. 739.

Miscellaneous Processes and Products

Standardization of Assembled Military Truck Parts; THE JOURNAL, July, 1917, p. 87.

The Building of the United States Military Truck; THE JOURNAL, September, 1917, p. 173.

Spark-Plugs for High-Speed Engines; by Albert Champion. THE JOURNAL, September, 1917, p. 185. Reprinted in TRANSACTIONS, Vol. 12, Part II, p. 351.

The Manufacture of Plate Glass for Automobile Uses; by J. H. Fox. THE JOURNAL, November, 1924, p. 449; and April, 1925, p. 464.

Commercial Possibilities of Rubber-Electrodeposition Process; by J. W. Schade. THE JOURNAL, April, 1927, p. 521.

The Electrodeposition of Rubber; by S. E. Sheppard. THE JOURNAL, April, 1927, p. 514.

GENERAL

Metallurgy in the Automotive Industry; by Ralph H. Sherry. THE JOURNAL, October, 1917, p. 246. Reprinted in TRANSACTIONS, Vol. 12, Part II, p. 323.

Automotive Industrial Efficiency; by G. C. McMullen. THE JOURNAL, January, 1918, p. 71.

Need for Researches on Automobile Parts; by William T. Magruder. THE JOURNAL, March, 1921, p. 255; and May, 1921, p. 439. Reprinted in TRANSACTIONS, Vol. 16, Part I, p. 306.

Production Engineering. THE JOURNAL, July, 1921, p. 75.

The Metallurgist and the Tractor; by C. S. Moody. THE JOURNAL, September, 1921, p. 189. Reprinted in TRANSACTIONS, Vol. 16, Part II, p. 442.

The Foremost Economic Force in the Automobile Industry. THE JOURNAL, December, 1921, p. 351.

Some Unique Features of Automobile Production; by William Dunk. THE JOURNAL, November, 1922, p. 398; and January, 1923, p. 25.

Experience Notes from a Production Note-Book; by H. J. Crain and J. Brodie. THE JOURNAL, November, 1922, p. 409; and January, 1923, p. 22. Reprinted in TRANSACTIONS, Vol. 17, Part II, p. 638.

Preparing and Loading Automobiles for Shipment; by B. R. Moore. THE JOURNAL, December, 1924, p. 511.

Six-Wheel Construction and Operation; by Ethelbert Favary. THE JOURNAL, April, 1925, p. 427.

Basic Factors of Production; by K. T. Keller. THE JOURNAL, November, 1925, p. 494.

Motorcoach Builder's Attitude Toward Changes in Standard Design; by E. W. Templin. THE JOURNAL, April, 1926, p. 379.

The Modern Automobile-Production Methods; by W. K. Swigert. THE JOURNAL, September, 1927, p. 286.

Relation of Metallurgy to Production; by J. M. Watson. THE JOURNAL, October, 1927, p. 370.

Operation and Maintenance

Activities of the Operation and Maintenance Committee and its Subcommittees since their formation were reported and discussed at the session of the Transportation Meeting held in Chicago on the afternoon of Tuesday, Oct. 25. Voluminous data were presented, but the limitations of available space forbid their publication as a unit in a single issue and therefore some of the committee reports are herewith presented first; the other reports, the data and the discussion at the meeting being reserved for subsequent publication.

REPORT OF THE MAIN COMMITTEE

First Formal Report Outlines Development Work Done and Future Activities

This is the first formal report to be presented to the Society on behalf of the S.A.E. Operation and Maintenance Committee. The committee was authorized in June, 1926, by the Council of the Society, and became active in the fall of that year. One meeting was held on Oct. 11, and plans were then made for a group of subcommittees assigned to the study of definite subjects. Members were also assigned as contacts with the other regular or standing committees of the Society. These plans have formed the foundation for the work this year, or rather for the period since early in February, 1927.

Even before the committee was organized, considerable thought had been given to the necessity for it and to a program. Perhaps the beginning of this attention to the membership concerned with the utilization of motor-vehicles, as distinct from their design or production, was the action taken early in 1925, when the voting members of the Society approved an amendment to the Constitution which specifically included within the full-member grade those in responsible charge of the utilization or maintenance of automotive vehicles.

The next step was taken at the Dec. 17, 1925, meeting of the Metropolitan Section, which had been active in the discussion of engineering problems peculiar to operation and maintenance, by and for the members engaged in those branches of the industry. Suggestions were made and approved at the meeting that the Council be requested to consider the advisability of formulating a standard cost-system for motor-truck operation, and of the Society's giving further attention to the professional needs of members in the operating group.

The committee's work to date, particularly in the study of accounting, regulation, and of general operating practices, serves to emphasize the lack of any broad, organized efforts to improve the large-scale operation of motor-vehicles. The committee is moving through practically virgin territory, doing things that never have been done before and with the ends to be accomplished sometimes in doubt, so that it is necessary to change and mold them as the work progresses.

Subcommittees and Their Work

The West-Coast Subcommittee, under the leadership of E. C. Wood, Vice-Chairman of the Operation and Maintenance Committee, was asked to make a comprehensive review of conditions in its territory. On account of the impossibility of direct contact between the committee members in the different sections of the Country, it was deemed best to ask this subcommittee to prepare a descriptive report. This report, by the attention it gives to important motor-vehicle parts, furnishes a starting point for the study of equipment which it is believed should be continued, possibly along more analytical lines, in the future work of the committee.

The Subcommittee on Motor-Vehicle Regulation, which originally was asked to study conflicting legal requirements for engine-identification numbers, has broadened the scope of its activities and has undertaken to consider the Hoover Uniform Motor-Vehicle Code from the point of view of the large-scale operators of motor-vehicles. One reason, perhaps the controlling reason, for entering the field was the fact that very little consideration appeared to have been given to the requirements of the large-scale operators.

The Subcommittee on Accounting has held five meetings, has conducted a great amount of correspondence, and has collected much material which remains to be utilized. The report to be presented for this subcommittee suggests a definite plan for its future activities, and also brings out the need for an intelligent discussion of matters of policy, particularly as to whether the subcommittee's investigation should embrace the complete field of accounting and cost-keeping, including overhead or administrative expense, and whether it should consider the broadest requirements, such as those of the motor-transport company, the commercial trucker, the motorcoach and the taxicab operators.

The Subcommittee on Education was asked to develop interest in the work of the main committee among all the members of the Society. One way of doing this was by joint meetings participated in by various Sections of the Society and by the local organizations of service managers and of the men in charge of motor-transport installations. To show that the suggestion is practicable, such a joint meeting was held Sept. 30 in Los Angeles with nearly 200 members of the participating organizations present. It is Chairman Favary's recommendation that similar meetings on the same subject should be promoted by all the other Sections of the Society, and the committee believes this should be done.

Main Activity of General Committee

A meeting of the general committee was held at French Lick Springs, Ind., during the Semi-Annual Meeting of the Society, for the purpose of discussing problems regarding which the operating members might receive assistance from the Research Committee and the Research Department of the Society. Several subjects were referred to the Research Committee that are now being considered, it is understood. One of the most important of these is the formulation of specifications and test methods for the purchase of lubricating oils.

The activities of the 1927 Committee on Operation and Maintenance have consisted mainly of carrying on the study of topics suggested by the 1926 committee. For that reason little consideration has been given to matters of vehicle design and construction, and to certain problems, such as labor-saving tools and garage construction, that are of interest to the members connected with the service stations of dealers and manufacturers.

This has been a year of breaking ground, of feeling the way in the dark, which probably was to be expected. For the immediate future, it is believed the committee should be organized in geographical groups so that the members of each group can meet at necessary intervals instead of attempting to carry on the work by mail. To each group should be assigned definite subjects with clear-cut instructions as to what is to be done with them. The object of the study should be to bring out summaries of experience and recommendations for good practices rather than to set down a mass of undigested and unanalyzed facts, interesting though they

may be, that would be better suited for presentation as a paper before this or similar meetings. It will be necessary to collect certain facts to determine what practices are being followed by the large operators, but these should be merely a starting point or foundation. Finally, these groups or subcommittees should not be swayed unduly by majority opinions or practices. It should be their function to dig deep, study underlying principles and recommend better methods than those in vogue if change is believed justified.

R. E. PLIMPTON, *Chairman*,
S.A.E. Operation and Maintenance Committee.

STUDY OF NOMENCLATURE DESIRED

Procedure Proposed by Subcommittee To Create a Suitable Specific Vocabulary

The Subcommittee on Nomenclature deemed it advisable to defer its activities until such time as the Subcommittee on Accounting can furnish a list of terms requiring definition and standardization as to distinct meaning. This list should soon be available and no doubt will include such terms as: Operation, maintenance, depreciation, garage and shop "house service," garage service, supervision, and repairs. The present varied interpretations given to these few terms indicate the importance of defining a standardized meaning for each if the accounting plan under development is to provide comparable cost figures in fleets throughout the Country.

Taking one term from the foregoing list, "repairs," it brings to mind the following subsidiary activities arranged somewhat in the order of extent of operations: Inspection, tune-up, garage service, minor overhaul, major overhaul, reconditioning, and rebuilding. No doubt some other commonly used terms related to repairs might be suggested; but, even considering the foregoing list, where for instance does the "major overhaul" leave off and where does "reconditioning" begin?

If another subject such as the plant required by a fleet is in question, what is the difference between: Garage, garage shop, repair shop, central repair shop, and service station?

Again, for example, what is meant by the term "accessories"? Is the meaning "appurtenances"? Do you include truck-engine power-driven auxiliary equipment such as winches, pumps, hoists, and the like? "Equipment" is another term requiring definition.

The foregoing examples of the vast number of terms which must be defined do not even scratch the surface of the job confronting the Subcommittee on Nomenclature. It is the plan of the Committee to enlist the help of all fleet operators, who will be asked in the near future to furnish long lists of terms they wish defined. When these lists have been summarized, a questionnaire will be issued asking for definitions of the terms. By consolidating the results of the questionnaire, we hope to lay the foundation for a standard nomenclature for the fleet operators.

F. K. GLYNN, *Chairman*,
Subcommittee on Nomenclature.

REPORT ON COST ACCOUNTING

Suggestions on Procedure for Standardization Solicited by the Subcommittee

In presenting this report on accounting practices to the members of the Society and to the industry at large, the subcommittee wishes to explain that it is intended to draw out discussion and comment rather than to recommend fixed and final principles. So many complicated and difficult problems have arisen in the work that it seems inadvisable at this time to propose a standard classification of accounts. Such a classification may be desirable, and it is believed that the investigation of its possibility should be continued on the basis of the information already secured.

Much confusion has developed as to what the purpose of this investigation is or should be; in fact, the object or purpose has changed and developed gradually. Its evolution may be traced by reference to the following excerpts:

(1) Since no uniform cost-system is in general use by which operators of trucks can compare costs and performances, it is felt that the development of such a system by the Society would meet as important a need of the operators of trucks as have many of the services rendered by the Society in general. (From a paper by C. W. Sater, presented at the Dec. 17, 1925, meeting of the Metropolitan Section, New York City)

(2) Mechanical costs such as repair parts, maintenance and depreciation, should be considered rather than operating expenses such as drivers' wages, rent and insurance. A standardized classification should be arranged so that costs can be entered finally on some uniform basis such as "cost per mile," with the knowledge that this cost includes certain definite items. (From minutes of the meeting held April 16, 1926, of a committee appointed by the Council to report on the desirability of having the Society take up the study of cost systems and other matters of interest to operation and maintenance members)

(3) A subcommittee should be appointed to prepare a report on a standardized accounting-system coordinated with that of the American Electric Railway Accountants' Association and in cooperation with the various business associations which have developed accounting systems. (From minutes of the first meeting of the Operation and Maintenance Committee, held Oct. 11, 1926, at New York City)

(4) We should first accumulate all the information possible as to standardization by associations of accountants and accounting, particularly relating to classifications of operating and maintenance costs for motor-vehicles. The various points of view must be considered of the common carrier, of the industrial or business organization operating motor-vehicles as an adjunct to some other work, and also of the private carrier. If there is little or no association information available, we should go directly to the larger operators to get a good cross-section of the best practice, by thus determining what classifications of accounts are used and what statistics are taken from the accounts as a means of control and check of the personnel and the equipment. After we find out what has been done or is being done, we can compare and analyze the facts and determine whether it is worthwhile to formulate a system of our own or whether we should develop principles that ought to be followed in all systems. (From the tentative program submitted March 30, 1927, to members of the Operation and Maintenance Committee by R. E. Plimpton; also approved at the March 28, 1927, meeting of the Accounting Subcommittee)

COOPERATION SOUGHT AND OBTAINED

Five meetings of the Subcommittee on Accounting have been held in 1927 to date. To these all the members of the Operation and Maintenance Committee were invited, as well as others interested in the investigation. The primary function of the subcommittee is to evolve a system of cost determination for motor-vehicles which will make possible a comparison between companies of the items entering into expenditures for operation, including maintenance; second, to continue the study of the practices and principles relating to such items as may be of broad interest.

In the carrying out of the accounting investigation it was

soon appreciated that cooperation from as many sources as possible is needed. It was felt that other societies or associations likely to take up the subject should be notified of the work being done by the Society. To accomplish these ends, three circular letters were sent out by the Society on behalf of the committee.

Beginning in April, 1927, letters were sent to about 150 large-scale operators, mostly in the motor-truck field, and to industrial or trade associations whose memberships are interested in this subject. The response has been most cordial and helpful. About 50 returns have been received from a variety of industries. Many of them enclosed complete sets of forms used in their motor-transportation departments, as well as detailed explanations of the methods followed.

At the meeting of the Subcommittee on Accounting held June 28, 1927, it was suggested that the manufacturers of motor-vehicles should be communicated with regarding the investigation. Consequently, a letter was sent out July 7 to a list of 73 makers of trucks, motorcoaches and taxicabs, and to a few of the passenger-car companies which sell their product to large-scale operators. Of these, 30 of the larger companies asked for and received further information and replied to the inquiries made.

Interest of Diverse Industries Shown

Progress reports of the accounting investigation have been printed regularly in THE JOURNAL, and have been used to a gratifying extent by the important newspapers of the Country. It was felt that the trade and business periodicals of industries using motor-vehicles on a large scale should have these reports, with a view to enlisting the cooperation of their readers. A circular letter was sent July 28 to a selected list of some 60 periodicals. Accompanying the letter was an advance copy of an article later published in THE JOURNAL, and a reply-card to indicate whether they desired further information as it was available. About 20 of them indicated interest and only 2 said that they were not interested. Among the industries represented by those asking for further data were the grocery, butchers and packers, chain store, electric railway, central station, furniture, accounting, laundry, milk plant, bottling and retail coal industries, not to mention others in the automotive and general-management fields.

The list of industries just given suggests a possible plan for the future work of the subcommittee; namely, to select "key" industries and to make an intensive and thorough study of their motor-vehicle conditions. Information has already been collected from a considerable number of associations which represent a few of what may be considered the "key" industries. In addition to having the accounting recommendations of these associations, the details of the systems of one or more of the members of each have been collected. Most of the associations have accounting committees or experts connected with their staffs, all of whom have signified their willingness to cooperate.

Some Questions That Arise

It may be asked: Of what value is the intensive study proposed for such a limited group of industries? The main advantage would be to provide working data for use in formulating principles or a classification when the time for that comes. Other questions are: What should the committee recommend in connection with depreciation, interest, and overhead charges? Should its tentative classification be arranged so that these important industries can use it as a meeting ground, any one with any other, to compare details of operating costs or expense? To what extent should the motor-transportation department be considered as a separate business, working to a definite annual budget or charging other departments for transportation services rendered? These are some typical problems that must be settled in connection with this study of accounting.

In concluding this report and in submitting it to all those concerned with the utilization and manufacture of motor-vehicles, the subcommittee wishes to convey its appreciation of the support it has received. The time and trouble taken in supplying information by so many competent and well-informed authorities is certainly an index of the value of the study and of the necessity of going ahead. There is much to be done, and results cannot always be secured in a short time. But with patience and perseverance, the study is bound to be of great benefit to the public, to all users of business motor-vehicles and to the manufacturers, all of whom are vitally concerned with the efficient application of this modern form of transportation.

R. E. PLIMPTON, *Chairman*,
Subcommittee on Accounting.

REPORT ON STATE REGULATIONS

Subcommittee Outlines How Differing State Laws Handicap Effective Operation

There is no question of the desirability, or even of the necessity, of efforts to secure not only uniformity of but also proper State regulation of motor-vehicle construction and operation. One example of the difficulties arising from the lack of uniform State regulation is the differing requirements of contiguous States as to the location and color of motorcoach marking and destination lights. Other requirements in which differing State regulations unnecessarily handicap interstate operations are:

(1) Varying requirements as to maximum dimensions
(2) Requirements in some States that the driver's seat be partitioned from the remainder of the vehicle, and in other States that there shall be no obstructions within the vehicle which prevent a full view of the interior
(3) Differing requirements as to the color of stop-lights
(4) Differing requirements as to emergency motor-coach-doors
(5) Differing specifications as to the maximum width of service doors and the like

Fleet operators often are unnecessarily handicapped by State legislation. The interchange of engines between vehicles, which is often required in fleet maintenance, can be accomplished in many States only after compliance with certain rules which may keep a vehicle out of service a week or so longer than is necessary to accomplish the change.

In their maximum-weight provision, several States prevent the most efficient use of six-wheel vehicles by limiting the six-wheel truck to the same load as that of a four-wheel vehicle, in spite of the fact that the weight distribution of the former results in less damage to the roadway. The use of these vehicles is discouraged.

The Society now includes in its membership a large number of fleet operators as well as engineering officers of automotive manufacturing companies, and the interests of the first group require some concerted effort in this field.

The Operation and Maintenance Subcommittee on Motor Vehicle Regulation was organized to act in an advisory capacity, technically, to the several other bodies which are attempting to bring about more uniform and correct motor-vehicle regulation. There is no thought that this subcommittee shall attempt, directly, to secure the passage, amendment or repeal of any bill or law. It recognizes that, if its study is to be of benefit, it must be coordinated with the work which has been done along this line and must be in cooperation with the bodies which are attempting to work with the State legislatures in preparing appropriate statutes.

The two subcommittee meetings that have been held up to this time have been devoted to a discussion of the several phases of the subject and of the way in which the committee should proceed. Copies of the proposed Hoover Code have been distributed and its various recommendations discussed. So far, the subcommittee has made no definite recommendations as to existing or proposed legislation.

F. J. SCARR, *Chairman*,
Subcommittee on Motor-Vehicle Regulation.

Standardization Activities

FANS, BELTS AND PULLEYS

Subdivision Report Revised by Engine Division and Approved as an S.A.E. Standard

The subdivision report on the revision of fan-belts and fan pulleys, printed in Standardization Activities in the October, 1927, issue of THE JOURNAL, was submitted to the S.A.E. Engine Division meeting on Oct. 25 for consideration and the resultant discussion brought about further revision.

It was voted to change the title to Fans, Belts and Pulleys and to recommend the new specifications as an S.A.E. Standard rather than as S.A.E. Recommended Practice, as it was felt that the specifications were sufficiently well established in the industry to warrant their publication as a standard.

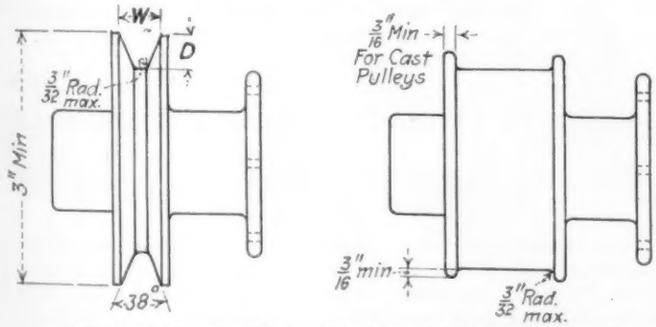
One of the major amendments to the subdivision report is the elimination of the illustration of the belt in the drawing of the grooved pulley and the consequent revision of former Table 2, now Table 1, to show the width of the pulley groove *W* and the depth of the pulley groove *D* rather than belt dimensions.

Revised specifications to be presented to the Standards Committee for approval are as follows:

FAN BELTS AND PULLEYS
(*S.A.E. Standard*)

Pulley Diameters.—To insure long belt life, diameter of fan driven-pulley should be made as large as possible consistent with size of fan. Recommended diameter of fan driven-pulleys not less than one-fifth of the diameter of fan and not less than 3¼ in. in any case. Diameters of fan pulleys to be given in increments of not less than ¼ in.

Angle of Groove.—An angle of 38 deg. shall be used for driving fans only or fans and accessories.



Note: Driving pulleys for flat belts shall be crowned and without flanges.

TABLE 1—V-FAN-BELT AND PULLEY DIMENSIONS

Width of V-Groove at Top, In. *W*	Minimum Depth of Groove, In. *D*	Maximum Fan Diameters Inclusive, In.	Maximum Projected Blade Width, In.
5/8	9/16	Up to 14	1 5/8
5/8	9/16	15 to 18	1 7/8
3/4	11/16	19 to 20	2 1/4
1	15/16	21 to 22	2 1/2
1 1/4	1 1/8	23 to 26	2 1/2

Note: For heavy industrial service, twin belts are recommended on fans 26 in. in diameter or larger instead of one wide belt.

Width of Belt.—The width of the belt shall be equal to the width of the pulley groove measured on its outside diameter. For link-belts the next larger size pulley should be used.

Angle of Belts.—The included angle of the sizes of rubber belts shall be 42 deg. to allow for the bulging of the inside of the belt when laid around the pulley. The included angle of leather belts shall be 38 deg.

Finish of Pulleys.—Driving surfaces of pulleys shall be smooth and free from tool or chatter marks.

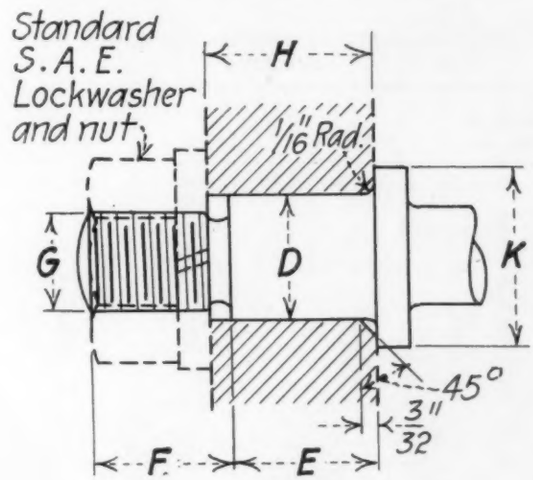


TABLE 2—FAN-PULLEY SPINDLES FOR SOLID FAN-BRACKETS

Width of Belt, In.	*D*	*E*	*F*	*G*	*H*	*K*
1–1¼	0.748 0.746	7/8	7/8	5/8–18	1	1
1½	0.873 0.871	1	7/8	5/8–18	1 1/8	1 1/8
2	0.998 0.996	1 3/8	1 5/16	3/4–16	1 5/8	1 1/4
2½–3½	1.248 1.246	1 9/16	1 5/16	1–14	2	1½

TABLE 3—FLAT FAN-BELT AND PULLEY DIMENSIONS

Belt Width, In. ±1/32	Pulley Width, In. ±0.01	Maximum Fan Diameters, Inclusive, In.	Maximum Projected Blade Width, In.
1	1 1/8	Up to 14	1 5/8
1¼	1 3/8	15 to 18	1 7/8
1½	1 3/4	19 to 20	2
2	2 1/4	20 to 22	2 1/4
2½	2 3/4	21 to 24	2 1/2
3	3 1/4	25 to 28	2 1/2
3½	3 3/4	29 to 36	3

Length of slot to allow for ½-in. take-up per foot of belt length.

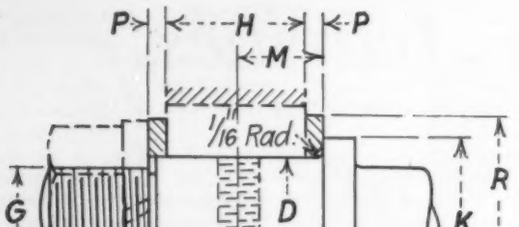


TABLE 4—FAN-PULLEY SPINDLES FOR SLOTTED FAN-BRACKETS

Width of Belt, In.	1–1¼	1½–2	2½–3½
D	0.873 0.871	0.998 0.996	1.248 1.246
E	1 3/16	1 3/16	1 7/8
F	13/16	13/16	1¼
G	5/8–18	¾–16	1–14
H	1	1 1/8	1½
K	1	1¼	1½
M	5/8	13/16	1
N	5/16–18	½–20	½–20
P	3/16	¼	¼
R	1 3/8	1¾	2

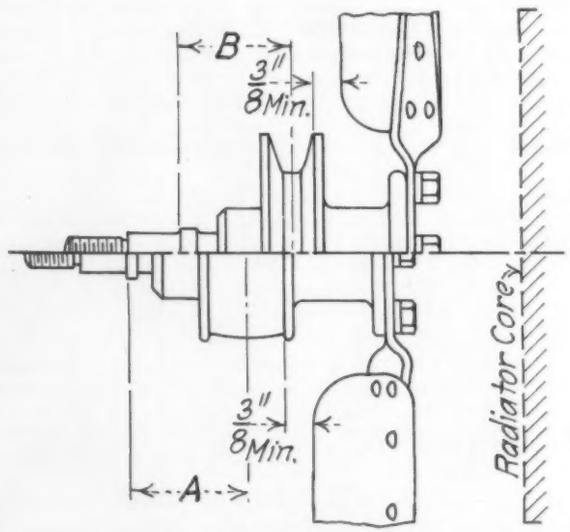


TABLE 5—FLAT AND V-BELT FAN-ASSEMBLY DIMENSIONS

Belt Widths, In.		*A*	*B*
Flat	*V*		
....	5/8	...	1½
...	¾	...	1¾
1	1	1¾	2 1/8
1¼	1¼	1¾	2 1/8
1½	...	1¾	...
2	...	2	...
2½	...	2½	...
3	...	2½	...
3½	...	2¾	...

Note: When no shroud is used, front edge of fan blade shall be not more than ¾ in. from core.

RADIATOR-LACING REVISION APPROVED

Subdivision Develops Quality Recommendations and New Table of Dimensions

The report of the Subdivision on Radiator Lacings, printed in Standardization Activities in December, 1926, was submitted to the S.A.E. Engine Division meeting on Oct. 25, 1927, for consideration and was approved. The specification, which is reprinted herewith, will take the place of paragraph 3 of the radiator standards appearing on p. 19 of the September, 1927, issue of the S.A.E. HANDBOOK under the heading Hood Lacings and will be submitted to the Standards Committee for approval as an S.A.E. Standard. The sizes proposed are in accordance with the minimum requirements given in the present specification for hood lacings.

PROPOSED RADIATOR HOOD-LACING SIZES

(*S.A.E. Standard*)

Thickness, In.	Width, In.					
	⅜	½	⅝	¾	1	1¼
1/8	X	X	X	X	X	X
3/16	..	X	X	X	X	X

When woven, material shall be made of a good grade of cotton yarn woven solidly with a fine weave. It shall not contain jute. The finished webbing shall be thoroughly impregnated with a light solution of creosote or asphaltum cut in a solvent deodorized as much as possible. The finished lacing shall be flexible and shall retain its flexibility and resiliency.

CLUTCH-HOUSING HOLES CHANGED

In paragraph 1 of the present clutch-housing standard on p. 2 of the September, 1927, issue of the S.A.E. HANDBOOK the size of the cap-screw holes in the flanges with relation to the nominal diameter of the flywheel-housing cap-screw is specified.

As a result of a survey made to determine whether it would be advisable to enlarge these holes for assembly reasons, the matter was brought before the meeting of the S.A.E. Engine Division on Oct. 25 for consideration and the paragraph referred to was revised to read:

> The cap-screw holes in the clutch-housing flanges shall be 3/64 in. larger than the nominal diameter of the flywheel-housing cap-screw.

PROPOSED STORAGE-BATTERY TERMINALS

Revised Dimensional Specifications Only To Constitute New S.A.E. Standard

The report of the Subdivision on Storage-Battery Terminals, printed on p. 321 of the September, 1927, issue of THE JOURNAL, contained suggested specifications for such terminals including a chemical composition and a physical test. The latter two items constituted the major points of discussion when the report was submitted to the Electrical Equipment Division meeting on Oct. 31.

Aside from multiplicity of designs, which was objected to by the manufacturers of terminals, the main difficulties experienced with terminals are breakage and rapid corrosion. It was brought out that the breakage of terminals in service was due to defective terminals resulting from bad foundry practice, which in general can be traced to the use of scrap metals. For this reason it was felt that any attempt to limit the composition of terminals to any definite specifications would restrict manufacturers too much, as it is possible, by using all new metal, to employ a more inferior composition than would necessarily be specified to assure satisfactory terminals if made from scrap metal.

There is also the possibility that some foundry will develop an alloy other than brass or bronze which will be entirely suitable, and the inclusion of any chemical composition in-

volving copper, as proposed in the specification, would of necessity exclude such a new development as standard. As a result, the final draft of the proposed standard does not include a chemical composition.

The paragraph under the heading of "General Information," not a part of the specification proper, contains a note on the advised minimum copper content when a terminal is made of brass. It is also believed that the recommending of the minimum amount of copper will govern the maximum amount of zinc, the element on which the rapidity of corrosion depends to a great extent.

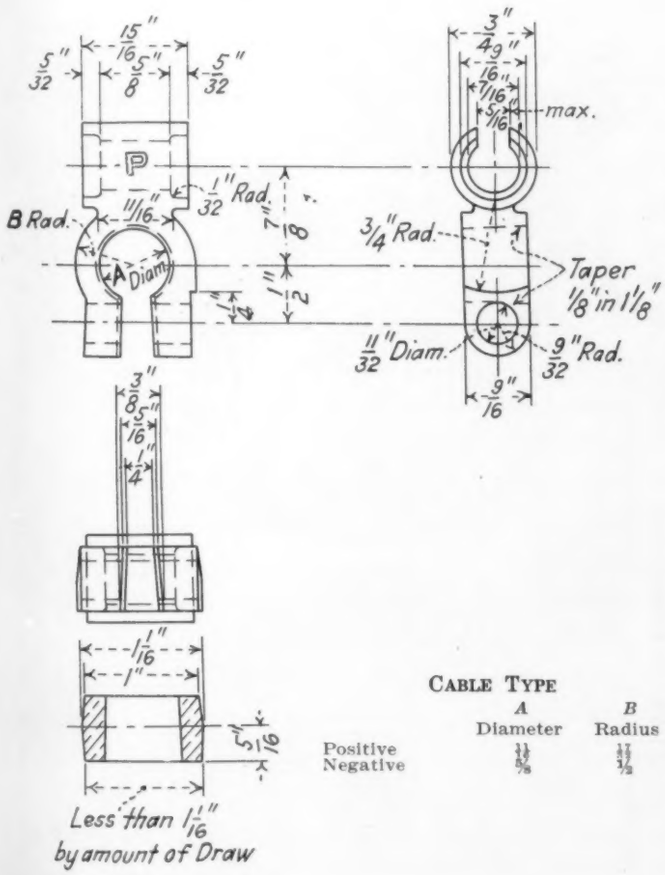
The opinion was generally expressed that the testing of terminals is largely up to the purchaser and that no standard test could be devised which would in all cases assure a satisfactory product. Likewise, there is a great divergence of opinion as to the relative merits of tensile-strength and bending tests. For this reason the aforementioned general information will also include a note as to the tensile-strength a suitable terminal should show.

When the dimensional specifications were brought up for approval, criticism of the 5/16-in. opening in the cable-type clamp was expressed owing to the fact that, when using some methods of assembling, cable strands slip through the opening unless the opening is smaller than specified. Therefore, to permit some users to have a slightly smaller opening, if desired, the 5/16-in. dimension was changed to read: "5/16 In. Maximum," it being felt that in the majority of cases manufacturers would adhere to the 5/16-in. dimension because of the saving of metal, if for no other reason.

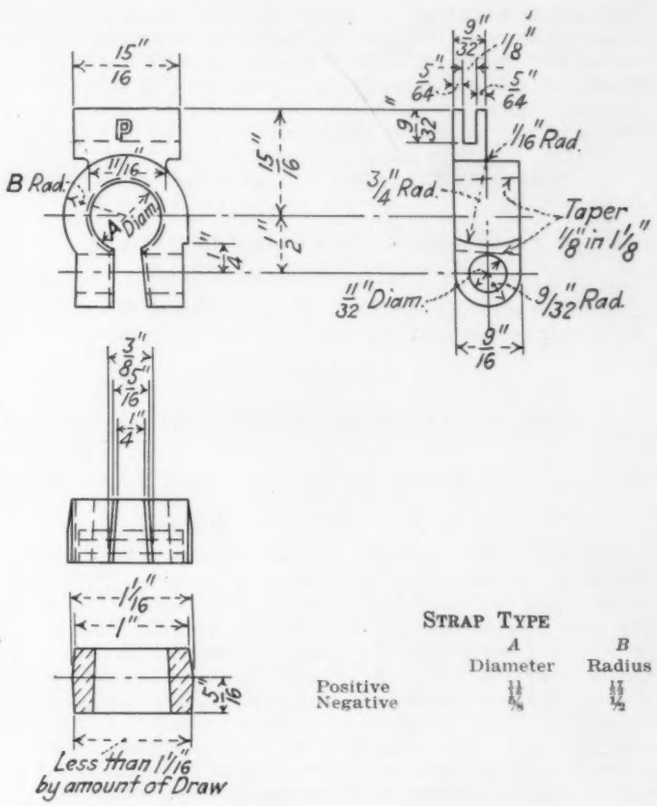
Question was also raised as to the subdivision's specification on the bolt hole, which called for a cored hole; therefore, in the final form, as approved by the Electrical Equipment Division, this is shown as a 5/16-in. hole, with no mention as to the method of forming the hole. The standard, as it will be submitted to the Standards Committee, is as follows:

STORAGE-BATTERY TERMINALS

(S.A.E. Standard)



CABLE TYPE	A Diameter	B Radius
Positive	11/32	7/16
Negative	5/8	1/2



STRAP TYPE	A Diameter	B Radius
Positive	11/32	7/16
Negative	5/8	1/2

(General Information)

It is recommended that the minimum copper content of storage-battery terminals be 75 per cent by weight, any less amount materially shortening the life of the terminal. A satisfactory terminal should show a minimum tensile-strength between the clamping jaws of the terminal of 300-lb. direct pull on a tensile-testing machine.

STORAGE-BATTERY REVISION APPROVED

Revision of the motorcoach storage-battery dimensions, as recommended by a subdivision of the Electrical Equipment Division and reported in the August, 1927, issue of THE JOURNAL, under Standardization Activities, was presented to the division at its meeting on Oct. 31. The report, as submitted, was approved by the division and will be put before the Standards Committee meeting in January for final approval.

VACUUM-BRAKE MANIFOLD CONNECTION

Motorcoach Division Approves 3/8-In. Tapped Hole in Manifold as Standard

The development of specifications for power-brake-compressor mountings and connections and vacuum-brake connections has been under consideration by a subdivision of the Motorcoach Division for some time.

The types of compressor now on the market vary so greatly in method of driving and mounting that no standard mounting specifications can be formulated. The number of manufacturers is small and there is no reason to doubt that, should other manufacturers enter the field, they would, for commercial reasons, follow the mounting dimensions of either of the two major types now built. For this reason the subdivision decided to give no further consideration to this phase of the subject.

However, it was thought advisable to set a standard tapped-

hole size in manifolds to permit the attachment of vacuum-brake equipment. The cost to engine manufacturers of providing such a hole at the time the engine is built is relatively small and, while the specifications are drawn up as a vacuum-brake-connection specification, it is anticipated that the providing of such a hole in the manifold will be of value as a connection for other vacuum attachments if desired.

The Standards Committee will be asked to approve the following:

Vacuum-Brake Manifold Connections

(S.A.E. Recommended Practice)

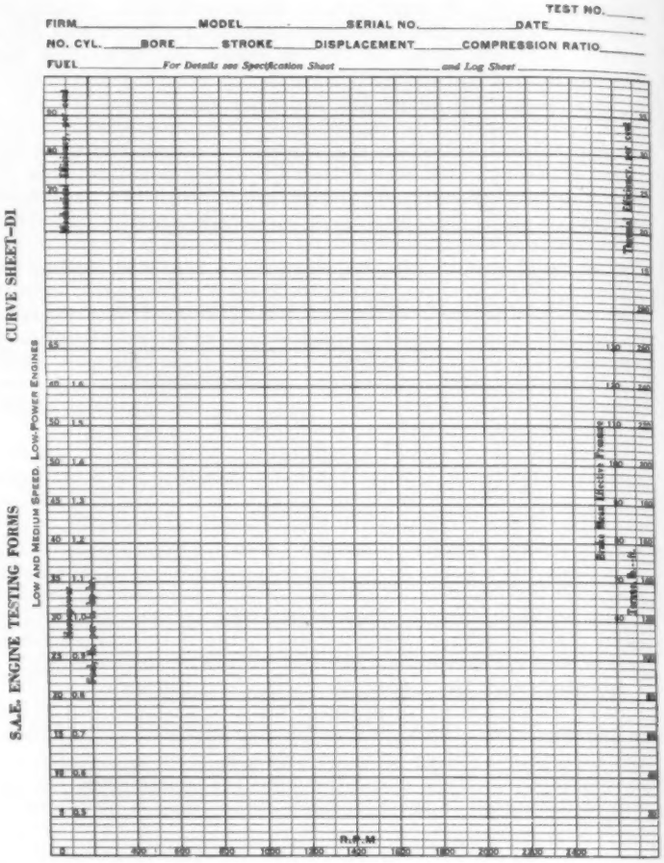
The vacuum-brake manifold connection shall be a ⅜-in. hole tapped with the American standard pipe-thread.

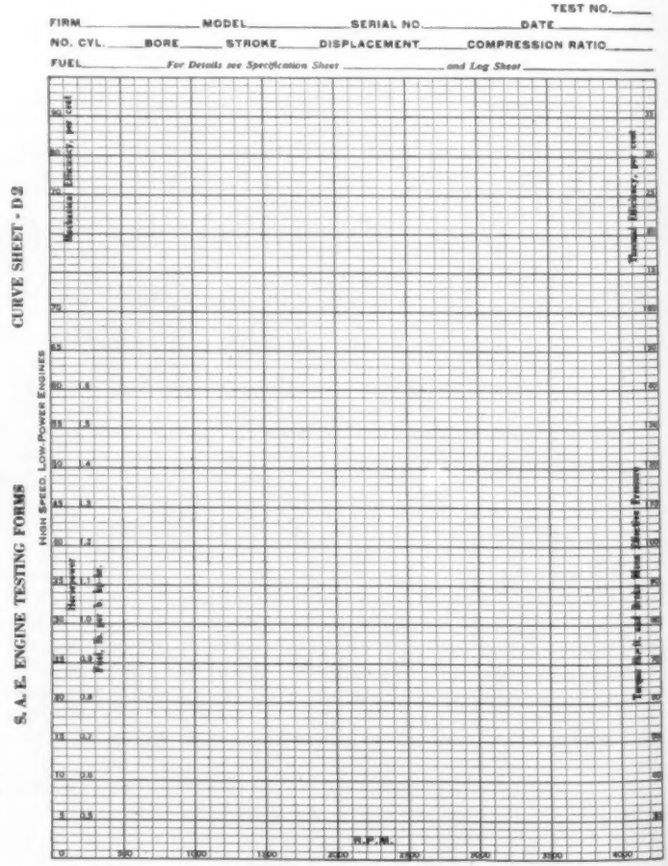
ENGINE-TESTING FORMS REVISED

Present Curve Sheets Changed and New Form Added for Large Engines

Following the adoption of the present engine-testing forms by the Standards Committee in January, 1927, additional suggestions were received for still further improving the curve sheets. It was also deemed advisable to attempt to develop a curve sheet for engines of larger size than heretofore provided for. The Subdivision on Engine-Testing Forms therefore continued its investigation along these lines through the medium of a survey requesting information from manufacturers of large rail-car engines and airplane engines and asking for samples of the forms used by such companies at that time for their large engines.

Because of the many and varied factors which the different companies wish to take into consideration when testing large engines, it is not thought possible to develop a form that will provide for the plotting of curves for all such items and, as explained later in the subdivision report,





CURVE SHEET - D3

S. A. E. ENGINE TESTING FORMS

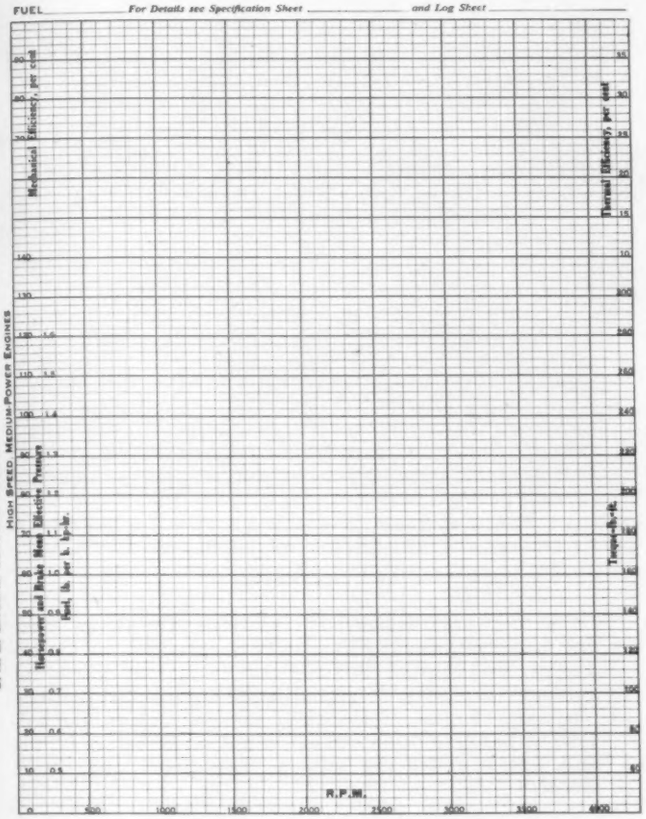
HIGH SPEED, MEDIUM-POWER ENGINES

TEST NO.

FIRM MODEL SERIAL NO. DATE

NO. CYL. BORE STROKE DISPLACEMENT COMPRESSION RATIO

FUEL *For Details see Specification Sheet* *and Log Sheet*



CURVE SHEET - D5

S. A. E. ENGINE TESTING FORMS

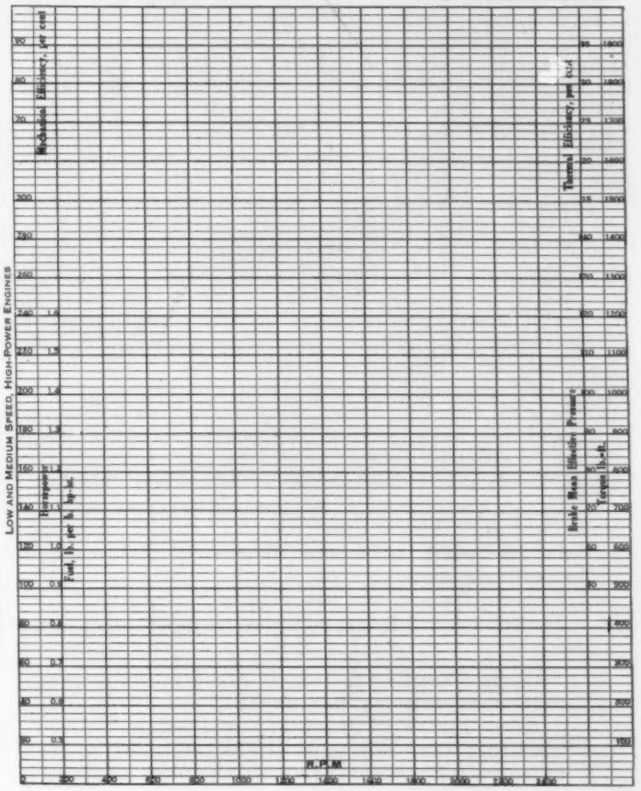
LOW AND MEDIUM SPEED, HIGH-POWER ENGINES

TEST NO.

FIRM MODEL SERIAL NO. DATE

NO. CYL. BORE STROKE DISPLACEMENT COMPRESSION RATIO

FUEL *For Details see Specification Sheet* *and Log Sheet*



CURVE SHEET—D4

S.A.E. ENGINE TESTING FORMS

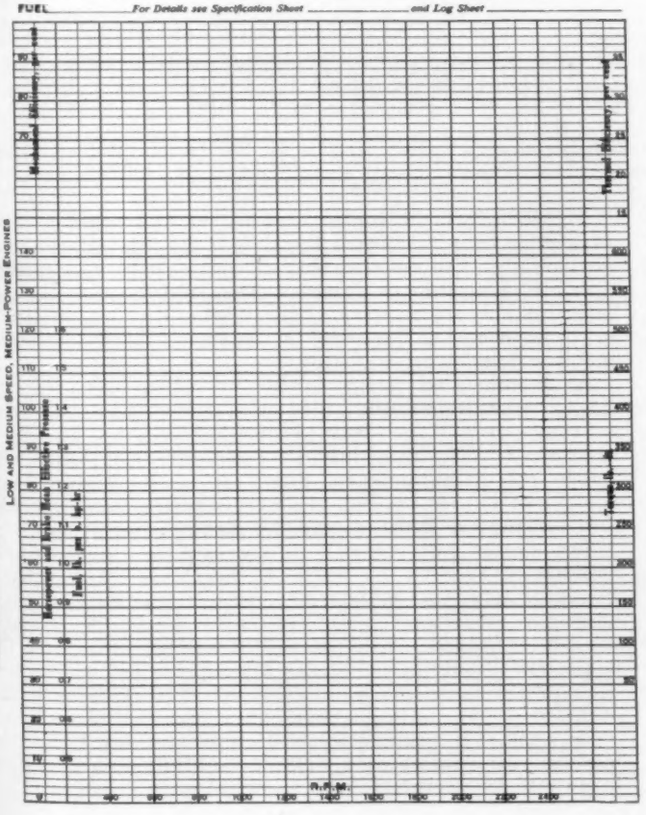
LOW AND MEDIUM SPEED, MEDIUM-POWER ENGINES

TEST NO.

FIRM MODEL SERIAL NO. DATE

NO. CYL. BORE STROKE DISPLACEMENT COMPRESSION RATIO

FUEL *For Details see Specification Sheet* *and Log Sheet*



CURVE SHEET—D6

S.A.E. ENGINE TESTING FORMS

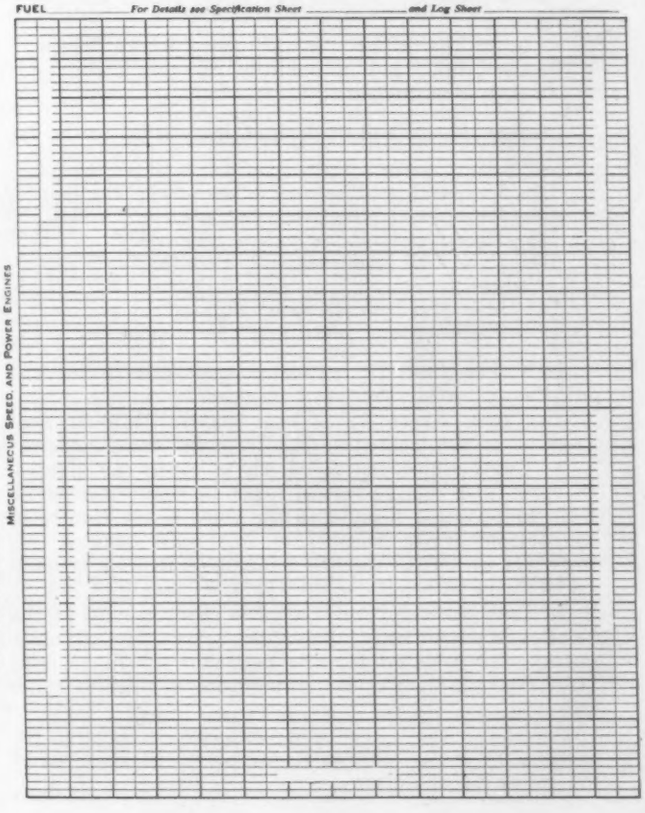
MISCELLANEOUS SPEED AND POWER ENGINES

TEST NO.

FIRM MODEL SERIAL NO. DATE

NO. CYL. BORE STROKE DISPLACEMENT COMPRESSION RATIO

FUEL *For Details see Specification Sheet* *and Log Sheet*



a blank form, as illustrated, has been proposed and approved by the Engine Division. [See p. 651.]

The following report, submitted by F. W. Sampson at the Engine Division meeting on Oct. 25, gives the revision of the existing forms as approved by the Division. The illustrations indicate the revisions as they will appear on the final forms and also present the proposed new form D6. [See pp. 650 and 651.]

Proposed Revision of S.A.E. Engine-Testing Forms

Proposed Curve Sheet D6.—It has been suggested that an additional curve sheet, D6, be drafted to cover tests of large-size miscellaneous engines. By carefully reviewing the replies from manufacturers circularized, it has been decided that a curve sheet of this suggested form would be almost impossible to draft in any usable form. In its place the Subdivision recommends the illustrated blank form, D6, for addition to the curve sheets D1 to D5 of the testing forms.

It is believed that this curve can be used by airplane, marine, and rail-car engine manufacturers, and in addition may be used by those who would like to use the S.A.E. Forms but who, for some reason, find the sheets D1 to D5 unsuitable for their purpose.

If the above sheet is adopted, it becomes necessary to change the word "five" to "six" in the heading of Sheet A under rules and directions of the testing forms in the sentence "(4) Curve sheets (furnished in five sheets for various size engines)".

The following changes are recommended in the curve sheets:

Change heading to side of curve sheets to provide more room for data at top.

Add "Test No." to top of curve sheets.

Change the heading on curve sheets D1 to D5 to agree with the heading on the new proposed sheet, D6. This provides for several items which have been requested and makes the curve sheets usable separately as well as in conjunction with a test.

Crowd all scales closer to the edges of the curve sheets. This gives more room for the curves.

Omit the word "Brake" in "Brake horsepower", making it possible to use this scale for friction and indicated horsepower.

Change the method of designating curves to the following:

D1—Low and medium-speed low-power engines
D2—High-speed low-power engines
D3—High-speed medium-power engines
D4—Low and medium-speed medium-power engines
D5—Low and medium-speed high-power engines
D6—Miscellaneous speed and power engines

On Curve Sheet D2, extend torque scale to 160 and add "lb-ft." after the word "torque".

On Curve Sheet D3, change torque scale to read from 60 to 300 located vertically in the same place.

On Curve Sheet D4, move R.P.M. scale one division to right and change torque scale to read from 50 to 600, the 50 being located on the third heavy line from the bottom of the sheet (1½ in.) scale bearing 100 lb-ft. per in. Thus the 600 remains as it is at present.

On Curve Sheet D5, extend B.M.E.P. scale to 140.

On Data Sheet A, one change is recommended in the rules and directions: under the correction formula change the wording for the definition of T_o to read "Observed absolute room temperature in degrees fahrenheit".

The log-sheet C has been criticized in several respects. It seems desirable, therefore, to recommend the following changes:

Move the columns for "Barometer, In. Mercury" and "Room Temperature" to the first and second columns below "Average R.P.M." respectively.

Add a column directly below these two columns labeled "Correction Factor," symbol C. F., formula

$$\frac{P_s}{P_o} \times \sqrt{\frac{T_o}{T_s}}$$

Add a column directly below "Brake Load at Arm R" (in Brake-Horsepower and Fuel Consumption) labeled "Brake Load, Corrected", symbol P_c, formula $CF \times P$

Remove the word "observed" from the columns
Torque Lb-Ft. Observed
Brake-HP Observed
Indicated HP Observed

Remove the columns
Torque Corrected
Brake-HP Corrected
Indicated HP Corrected

Leave room for five blank columns at the bottom of the brake-horsepower and fuel-consumption group.

Add a footnote to the bottom of the page to read as follows: "Above computed data corrected for barometer and temperature $\begin{matrix}\text{yes}\\\text{no}\end{matrix}$".

By way of explanation, the above alterations make the log-sheet usable for either a corrected or uncorrected test without the addition of a multiplicity of columns for both corrected and uncorrected figures. To make the use of the sheet perfectly clear, the following paragraph should be added on Sheet A of the test forms under the section "Log Sheet and Curve Sheet:"

If it is desired to correct data by the correction formula, the columns for correction factor, and brake-load corrected should be filled in, then P_c should be used to compute the data for the columns following.

DUPLEX-CARBURETER FLANGES

Dimensional Specifications to Be Developed to Assure Interchangeability

Increasing use of duplex carbureters has resulted in the suggestion that the Engine Division of the Society take under consideration the development of dimensional specifications for duplex-carbureter flanges. The subject was discussed thoroughly at the meeting of the Engine Division on Oct. 25 in Chicago and a summary of comments from carbureter manufacturers was submitted.

At present four makes of car are being equipped with duplex carbureters and it is understood that four more so equipped will go into production on Jan. 1. In an endeavor to meet this demand, carbureter companies heretofore not manufacturing this type are designing such equipment at present, and, to assure interchangeability when new designs are made, a standard flange is desirable.

The matter was referred to the existing Subdivision on Carbureter Flanges, of which E. S. Marks, of the H. H. Franklin Mfg. Co., is chairman, and it was decided to request this subdivision to meet in the early part of December. As a consequence, a meeting will be held in Detroit on Dec. 6, and all carbureter companies not represented on the Subdivision are to be invited to send a representative if they so desire.

Provided it is possible to obtain sufficient data before the meeting, the subject of air-cleaner mountings also will be taken into consideration.

FIG. 1—PARLOR-OBSERVATION TYPE OF MOTORCOACH FOR INTERURBAN TRAFFIC AND TRAIN-CONNECTION SERVICE

Motorcoach Design

By K. J. AMMERMAN[1]

TRANSPORTATION MEETING PAPER *Illustrated with* PHOTOGRAPHS

Success in building motorcoaches depends upon the ability to provide riders with safe comfortable rides in motorcoaches that can be operated at a profit.

The development of motorcoach construction parallels that of railroad coaches in many respects and is passing through the same course of evolution. But the demands on the motorcoach are more severe, for, in addition to higher maximum speeds, the vehicles must have greater accelerating and decelerating ability. This imposes greater strains on the chassis and body than do higher maximum speeds.

Simplicity is the predominating characteristic of good design and, when attained, is accompanied by low cost of maintenance.

Topics discussed by the author include the effects of excessive overhang, the importance of proper weight-distribution, the sales value of the comfort of passengers, the baggage problem, the value of sturdy appearance in enhancing the rider's confidence, the economy of standard body-building and the costs imposed by deviations from standardized design. Methods of construction are illustrated and views of several leading types of motorcoach are shown.

THE motorcoach manufacturer has an obligation to fulfill to the operator and the rider. Although selfish and not altruistic, it is nevertheless an obligation. This obligation is to provide the rider with a safe comfortable ride and to provide the operator with an economical, durable and amply powered motorcoach. The success of a manufacturer is measured by, and is in proportion to, his ability to offer the operator a motorcoach that, as a result of these qualities, will make it possible for him to sell a satisfactory ride to the public at a profit. The three words, "at a profit," could well be the subject of a separate discussion, but in this paper I wish to emphasize them as being the yardstick that is used to measure the success of a manufacturer's efforts in design.

Experience in the last few years indicates that motorcoaches, to be safe and durable under the impost of the fast schedules that are now effective in many localities, must approach railroad equipment in weight per passenger. Motorcoach engineers and manufacturers can improve and have improved somewhat on railroad-coach construction by using better materials and finer workmanship, but they are limited in this respect by the desire of the operator to buy at the lowest possible initial cost. Fine workmanship and high-grade materials are least visible to the operator where they do him the most good. Operators in many sections of the Country are seeking more and more speed, but they do not appreciate what the gratification of their desires will cost them. A motorcoach that is safe at 40 m.p.h. may not be safe at 55 m.p.h.

The evolution of steam-railroad-car construction provides a good example of the effect of speed on the weight requirements consistent with safety and durability. Only a few years ago a standard passenger-car weighed about 40 tons, while today a car having no greater passenger-carrying capacity weighs 60 tons. The railroads did not penalize themselves by this 50-per cent increase in dead-weight without good and sufficient reasons. Increasing the weight raised the operating cost without increasing the revenue to match it. The reason for increasing the weight was the de-

[1] Executive, American Car & Foundry Motors Co., New York City.

mand of the traveler for higher speed. The railroads tried to meet this demand with the equipment available, but the light equipment then in use would not withstand the terrific strains imposed upon it by the higher speed and was not safe.

The motorcoach today is going through much the same evolution, an evolution more vigorous than that of the steam railroad, for, in addition to the demand for higher maximum speed, the demand is for greater acceleration and deceleration. Acceleration and deceleration have a much greater effect on the schedule speeds of the motorcoach than on those of the railroad because of the far more frequent stops. Acceleration and deceleration also impose strains on the chassis and the body far greater than does increased maximum speed. It is therefore inevitable that, if the demand for increased schedule speed is to be met, the coaches must be more heavily built and their cost consequently will be proportionally higher. Conversely, it is evident that, if they are to live long, light-weight large-capacity motorcoaches must be slow and sluggish.

Simplicity Characterizes Good Design

Simplicity in chassis design, so far as it is consistent with ability to perform the service for which it is intended, is the predominating characteristic of good design. If simplicity is attained, the operator will benefit through the lower cost of maintenance. Simplicity, of course, is relative and, since nearly all engineering is a compromise between what is desired and what can be done, an engineer sometimes chooses a somewhat less simple design for a given part to achieve an objective in some other direction. I do not wish, therefore, to be understood as criticizing, from an engineering point of view, any given design which, from the point of view of the designer, is justified, but which, from that of the operator, appears to lack simplicity and its corollary, low up-keep.

An engineer, in designing the various units that make up a complete chassis, can achieve the desired results in several ways. Some engineers, for instance, mount the radiator on the chassis frame; others mount it on the engine. We all are conversant with the various types of valve mechanism, each of which, in the eyes of the engineer, has sufficient advantages to justify its use.

A division of opinion also exists as to the best place for the transmission: as a unit with the engine, or separated from it by a short drive-shaft with a universal-joint. In designing rear axles one engineer may prefer a full Hotchkiss drive; another may prefer driving through radius-rods. I do not think it is necessary, or desirable, to enter into a discussion of these various ways of designing a chassis, for the points are argumentative, and such a discussion would lead nowhere. The mention of several points in chassis design, however, will not be stepping too heavily on anyone's toes.

Effects of Excessive Overhang

The ever-increasing demand for passenger-carrying capacity has a tendency to influence engineers to design motorcoaches having excessive rear overhang. This influence is one easy to succumb to, for such a design achieves the desired results at a very low cost, as the wheelbase can remain the same and the frame channels merely be lengthened. The specifications with respect to overhang, as they now exist in those State regulations which cover this point, have no effect on limiting the overhang. I do not know of any motorcoach having an overhang that is not well within the most restricted limit. Regardless of any State regulation, it behooves motorcoach designers to curb this tendency, for excessive overhang increases the wear on the rear tires and makes turning difficult. I know of one case in which a motorcoach having more than the usual overhang was just able, after much backing and filling on the turns, to climb a winding road up a mountain famous for its scenery, but, on the return trip down the mountain, it was necessary in many places to chop down trees before the coach could round the curves. Although this is admittedly an exceptional case, the same condition exists in crowded traffic when sharp turns must be made, particularly in pulling away from the safety aisle or zone when a car is parked immediately in front of the point at which the coach has stopped.

Overhang in the front of a motorcoach is as important as overhang at the rear, perhaps more so, when driving around a parked car to pull up to a curb or a safety aisle, when excessive front overhang may cause injury to persons waiting to board the coach. Furthermore, sharp turns in city streets may result in long front overhang causing damage to vehicles coming out of the street into which the coach is turning.

Weight Distribution Affects Tire Cost

Hand in hand with the question of overhang comes the question of distribution of weight. Many operators have had sad experience in trying to show a satisfactory profit with motorcoaches so designed that they impose too great a burden on either the rear or the front tires. Since four tires are entirely practicable under the rear of a coach but are impracticable under the front, the logical ratio of weight distribution is 2 to 1. This ratio cannot be strictly carried out under all conditions, because of the shifting of the weight resulting from the number and the positions of passengers, the amount of baggage carried in the case of parlor-car coaches, and the number of standees in urban or street-car types. The necessity for adhering as strictly as possible to this ratio would not be so great were it not for the fact that the tires usually specified, particularly on heavy types of coach, are of a size just sufficient to carry the load. The tendency to keep tire sizes as small as possible is forced by the necessity for keeping the weight and the initial cost as low as possible. Although tires that are oversize for the weight they must carry would eventually prove beneficial to the operator through lower tire-cost per mile, the increased differential in price resulting from oversized tire-equipment is difficult for any one manufacturer to obtain.

If the proper weight ratio is not maintained, a size of tire must be specified that is sufficiently large to carry the under-tired end of the coach. This results in the other end being considerably over-tired, since equipping a coach with two sizes of tire is obviously impractical. The solution of the problem can have only one result for the operator; that is, excessive tire-cost per mile. In some cases, in which the distribution of weight is particularly poor, tires of special sizes might even be necessary to carry the load satisfactorily, to the obvious disadvantage of the operator.

Factors That Determine Passenger Comfort

Perhaps the most important item affecting the selling of rides is the comfort of passengers. The modern private automobile is a relatively easy-riding vehicle. Some modern motorcoaches are easy-riding and are equal to, if not better than, the best private automobiles, but some are about as comfortable as a lumber truck.

FIG. 2—METHODS OF BUILDING SIDE-FRAMES AND BACK-FRAMES ON JIGS AND ASSEMBLING STANDARD MOTORCOACH BODIES ON BUCKS

This Unit Method of Construction of Side-Frames and Back-Frames Makes It Possible To Repair a Badly Damaged Coach at a Low Cost Compared with That of a Custom Job. If an Operator Specifies a Decrease in Body Width That Makes Necessary a Change in the Sides Farther Back than the Rear of the Front Door-Posts, the Jig Shown in the Upper Left View Cannot Be Used and Custom Methods of Fabrication Become Necessary. The Upper Right View Shows the Building of Parlor-Type Body Backs on a Jig; Several Completed Backs Are Shown at the Left of the Jig. The Floor Is Built on Sills on a Buck, as Shown in the Lower Left View, and the Side-Frames and Back-Frames Are Then Assembled to the Floor. The Buck Remains Under the Work Until the Roof and Cowl Are in Place. Bucks Cannot Be Used When a Change in Body Width Is Required

Long wide springs having a period of vibration approaching that to which the human body is most accustomed, namely, that of walking, are the basis of riding comfort as provided by the chassis. In comfort afforded by a motorcoach body, the predominating factor is the seat cushion. In many cases, too little attention is paid to the relation between the vibration periods of the seat cushion and those of the chassis springs. The riding qualities of a seat cushion are frequently determined when the vehicle is standing still. Many designers think the problem has been solved when it has been appraised in this way, only to find, when the coach is running along the road, that the period of cushion vibration synchronizes with the period of chassis-spring vibration and produces most uncomfortable results.

Perhaps the most retarding influence on the use of motorcoaches as a means of transportation is the lack of leg room. In a great many coaches, a person approaching 6 ft. in height cannot sit without pressing his knees against the back of the seat in front of him. All the public-utility commissioners and inspectors whom I know are men of small or medium height, but some day a tall commissioner or inspector will ride in a coach with insufficient leg-room and will say, "Here is something we have overlooked."

Another problem that the motorcoach manufacturer has been attempting to solve is that of baggage carriage. To date, baggage has been carried in four ways: (*a*) a baggage carrier has been installed on the roof; (*b*) a space has been made available in the rear of the coach by using taxicab seats from the wheel-housing to the rear of the body; (*c*) baggage racks, of either the solid or the metal-rack type, have been placed above the heads of the passengers; and (*d*) the observation type of parlor-car, having capacity for baggage under the rear half of the body, which is elevated one-half story, has been introduced.

The baggage carrier on the roof will, in my opinion, gradually decrease in popularity because of its inaccessibility and comparative lack of protection for the baggage, although an attempt has been made to overcome this last objection through the use of a box, instead of rails, on the roof; but this detracts materially from the appearance of the coach.

The use of taxicab seats in the rear of the coach, while allowing baggage to be carried where it is protected, reduces the number of comfortable seats when passenger-carrying rather than baggage-carrying capacity is needed.

The remaining two types probably will predominate in the future. Overhead racks provide space for lightweight baggage which the passenger can handle as he

FIG. 3—ASSEMBLED PARLOR-OBSERVATION MOTORCOACH BODY, SHOWING COWL CONSTRUCTION

If a Required Increase in Width Is Not Too Great, the Contour of the Sides Can Be Brought in to the Cowl so that a Cowl of a New Shape Will Not Have To Be Made. Patterns Alone for a New Cowl Cost About $1,500. Any Change in Body Width Makes Necessary a Great Deal of Hand-Fitting of the Cowl To Obtain a Good Blending of the Lines of the Cowl with the Body Sides and Roof Corners

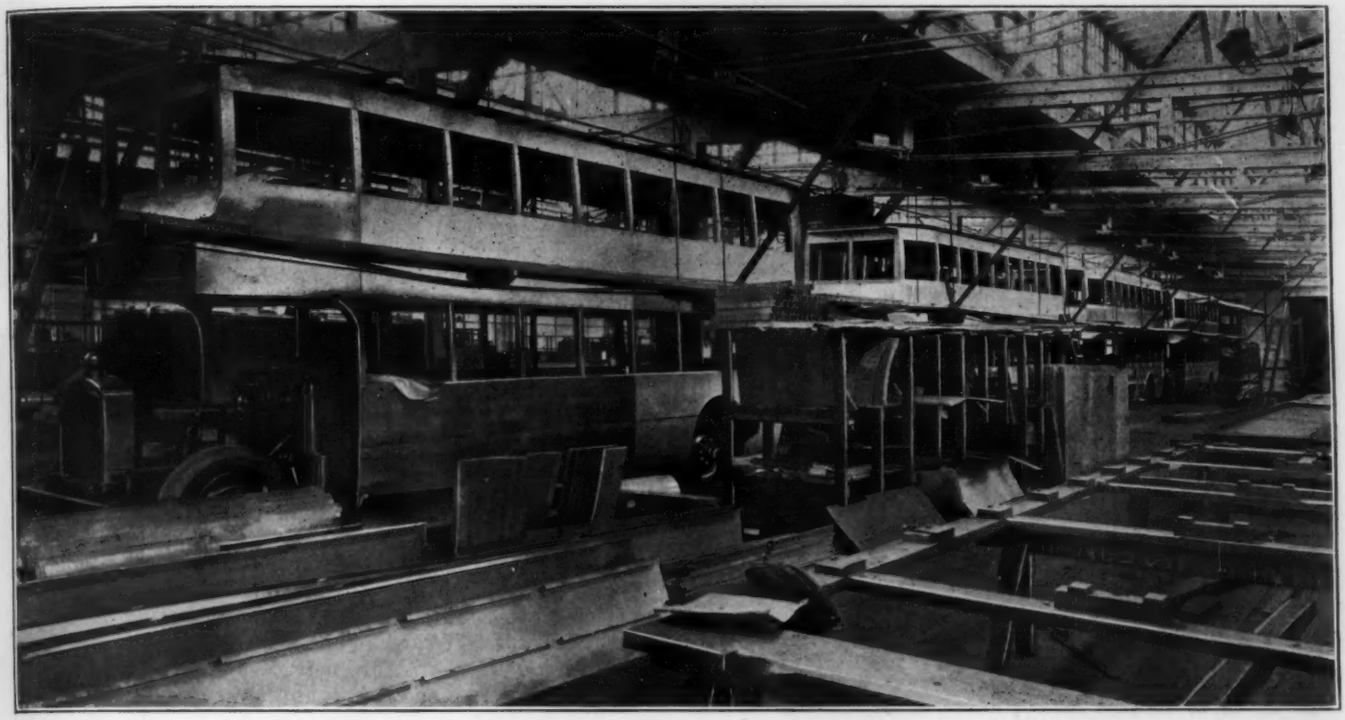


FIG. 4—COACHES IN THE BODY-PANELING LINE

Here the Paneling Is Placed on the Assembled Framework. In the Center of the View Is a Group of Racks Containing Panels Cut to a Jig and Ready for Assembling

does in a railroad train. This method will be convenient whenever a parlor-car type of motorcoach is used in territories in which the hauls are comparatively short.

The parlor-observation coach, of the type shown in Fig. 1, in which the baggage is enclosed in the lower rear half of the body, makes possible the carrying of steamer trunks as well as hand luggage. Although this type requires the attention of the driver when unloading passengers having baggage, this is not a serious objection in intercity operation, in which most of the passengers are unloaded at one terminal. This type of coach lends itself to two distinctive methods of operation. First, in territory dotted with small towns to which train service is infrequent, a traveling salesman in making his rounds can put his sample-cases into the baggage compartment, thus avoiding the necessity for hiring a car to take him to the next town or waiting several hours for a train. The second type of operation is through revenue-express service. Ability to lock the compartment will make it possible to develop express business and materially increase the revenue of the line without

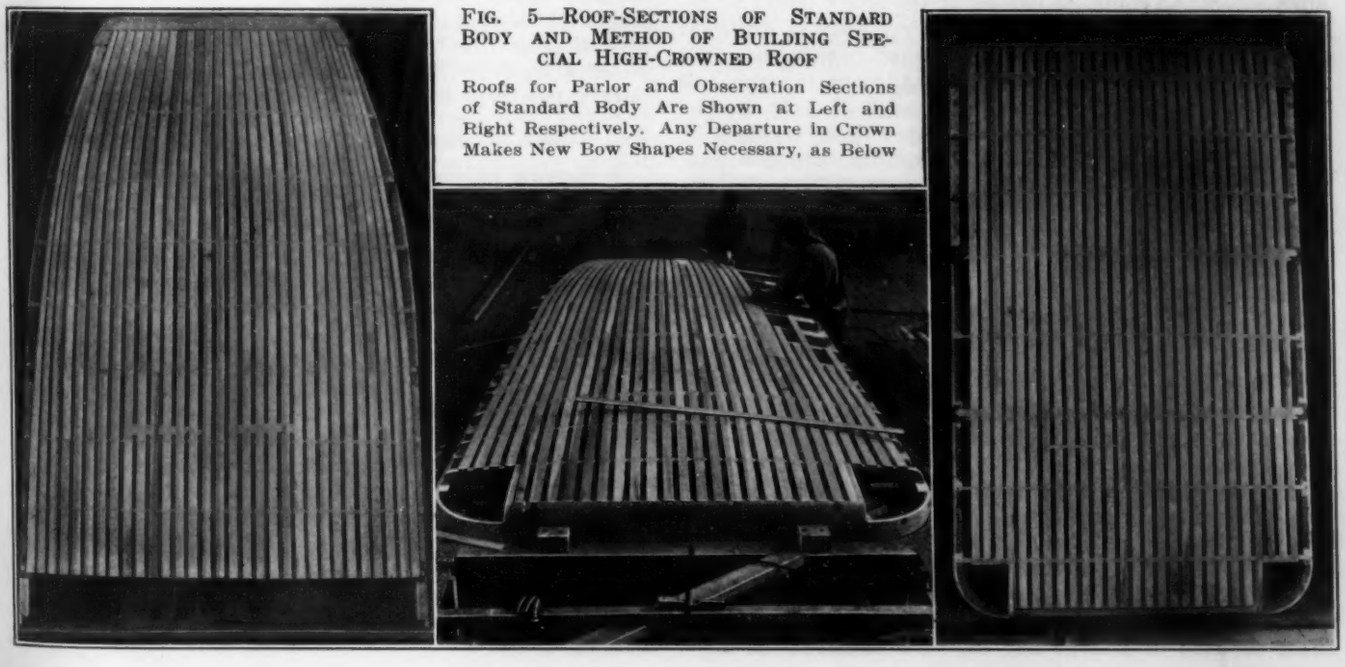


FIG. 5—ROOF-SECTIONS OF STANDARD BODY AND METHOD OF BUILDING SPECIAL HIGH-CROWNED ROOF

Roofs for Parlor and Observation Sections of Standard Body Are Shown at Left and Right Respectively. Any Departure in Crown Makes New Bow Shapes Necessary, as Below

interfering with the carrying of passengers. At least one such operation is now being developed in the East.

Sturdy-Front Appearance Gives Confidence

One point in the appearance, as well as in the sturdiness, of a coach that should receive more attention from designers, is the front of the coach, particularly the design and construction of the fenders. Ability to sell rides is determined largely by the confidence that the rider has in the coach. The front of the approaching coach is more clearly noted by a prospective customer than is any other part; and the sight of flapping fenders is not conducive of confidence in either the vehicle or the operating company, particularly when the fenders, through the buffeting of traffic, have lost whatever rigidity they ever possessed.

Economy of Standard Body

A subject close to the heart of the motorcoach manufacturer, which if it were nearer the heart of the operator would materially reduce the amount of his investment in coaches, is that of standard coach bodies. By a standard coach body, I mean a certain design of urban or parlor-car body that each manufacturer has developed and would like to put into production in a quantity that would reduce the cost to the minimum.

A large percentage of operators whose coaches run into two or three figures have preconceived ideas as to the ideal street-car or parlor-car body; the unfortunate fact is that no two agree. Many of the larger coach-operators, such as the railroads and the street-railways, have their own engineering staffs, which have been accustomed to making specifications for rail equipment and see no reason that they should not do the same thing for motorcoach equipment. Fortunately, this tendency toward special equipment is confined almost entirely to the coach body and not to the chassis.

The modern motorcoach body is not primarily a development by manufacturers alone, but by the manufacturers influenced by the years of experience of not one but hundreds of operators. I do not think that the variation in the transportation requirements of, say, 50 operators, is sufficient to justify 50 designs of coach body. These off-standard specifications do not, to be sure, affect the complete design of the coach body; sometimes the change is to a 5-in. narrower body, a different aisle-space, or a roof with 3 in. more headroom. One operator may desire 3 in. more headroom for the full width of the body; another may wish it only in the center, with a crowned roof that slopes down to sides of normal height. Simple as these individual changes may seem, they represent costs that are out of proportion to the benefits to be derived. Inability of the operator to appreciate the extent to which the increased cost of manufacturing must eventually be paid by him is due to his failure to understand the manufacturing changes made necessary by an apparently simple change in a dimension.

Results of Deviations from Standard Design

To give some idea of the increased cost resulting from apparently minor changes in bodies, I shall cite several examples of changes actually required on otherwise standard production bodies. In shops where bodies are built in small quantities and where production methods have not been established, each body is more or less a custom job. When custom methods are used, the cost of standard bodies is higher than it is when production methods have been adopted, and off-standard changes affect the cost to a large degree. The illustrations represent details of construction after production methods have been established.

Assume, for example, the changes necessitated are those resulting from an operator's requiring a parlor-car body a few inches narrower than the standard. An engineering layout must be made and detailed; special forms and templets must be made to produce the changed carlines, sills, quarter-sections, and the like; a new rear bumper may have to be designed; and, if special malleable castings are necessary, a delay of 30 days cannot be avoided.

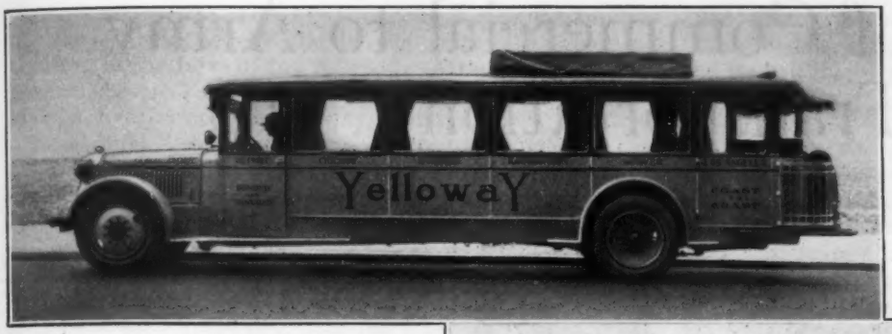
A parlor-car-body side-frame being assembled on a jig is shown in Fig. 2. If the required decrease in the width of the body makes necessary a change in the contour of the sides farther back than the rear of the front door-posts, shown at the extreme left of the upper left view, this jig cannot be used and the fabrication of the side becomes a custom job. The unit method of construction on jigs makes it possible to repair a badly damaged coach at a cost that is low when compared with that of a custom job. A fabricating jig for the back-frame and also several completed backs are shown in the upper right view of Fig. 2, while the lower left view indicates the method of building the sills and floor on a buck that remains under the work until the cowl, back, sides and roof have been assembled. When a change in width is required, bucks cannot be used, for their cost is too great to distribute over a few bodies. Inability to use the bucks for assembling doubles the labor cost, for the men are paid on the day-work instead of the piece-work basis.

Fig. 3 shows the completely framed and roofed parlor-car observation-type body and the type of cowl construction. If the change in width is not too great the contour of the sides can be brought in to the cowl so that a new cowl will not be required; but if the change is great a new cowl will be necessary, at a cost of approximately $1,500 for patterns alone. Even if a new cowl is not necessary to obtain a good blending of the sides with the cowl, a great deal of hand fitting is needed because the angle of the cowl posts is not right for the narrower body. This is particularly true with regard to the corners of the roof.

Fig. 4 shows the paneling line; in the center is a group of racks containing panels that have been cut to a jig and are ready to be attached to the framework. Fig. 5 indicates in the right and left views the types of construction of the front and rear roofs of the parlor-car observation-type body. A finished standard parlor-car observation type of coach is seen in Fig. 1.

Cost of Increasing Width and Headroom

A narrow parlor-car body, in some cases mounted on a narrow chassis, cannot always be blamed on the operator, for the laws of the State in which it is to operate may prohibit the use of what we regard as a standard-width coach. The cost of decreasing the width of the body an amount that does not require a new cowl is approximately $600. If a new cowl is needed, the share per coach of the additional $1,500 cowl-expense must be added to the $600. In another change required by an operator, the headroom over the aisle had to be increased 3 in. but the sides of the coach remained standard. Fig. 6 shows standard parlor-cars, except that the vehicle illustrated in the lower view has a special high-crowned roof to give 3 in. of additional headroom over the aisle. In the central view of Fig. 5 this roof is shown under construction. This change was relatively simple, but great care had to be taken so that the contour would appear to advantage from any angle, and the change cost $358.12.



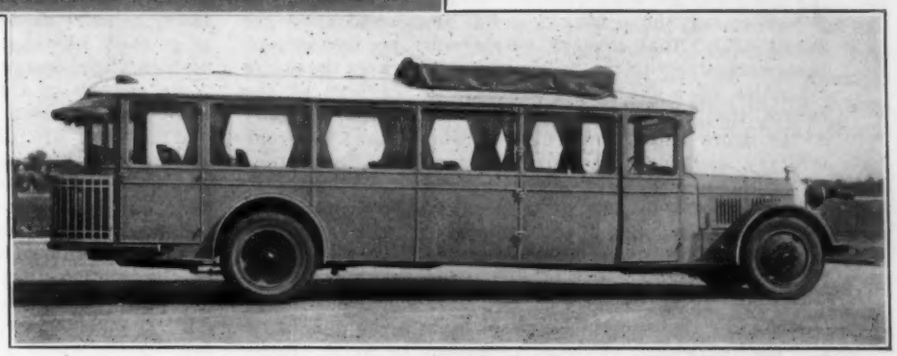


FIG. 6—STANDARD TYPE AND HIGH-CROWNED-ROOF PARLOR-CAR MOTORCOACH

In the Type of Vehicle Shown Above, Baggage Is Carried on the Roof and Protected by a Tarpaulin, but This Detracts from the Appearance of the Motorcoach and the Baggage Is Not Accessible. In the Motorcoach at the Right the Roof Is Crowned To Give 3 In. Additional Headroom over the Aisle and in This Respect Is an Expensive Departure from the Standard Construction

by the failure of vendors to supply special castings, seats, and the like. The vendor does not welcome special orders in small quantities that break into his steady production of a standard article, and belated deliveries usually result.

In conclusion, motorcoach manufacturers must lay particular stress on (*a*) simplicity, to decrease maintenance; (*b*) proper balance with respect to the weight and the overhang; (*c*) the comfort of passengers; (*d*) the carrying of baggage; (*e*) designs affecting the confidence of the public; and (*f*), by no means least, the developing of satisfactory body types and then selling the idea to the operators on the basis of lower investment costs.

These examples of changes from the standard construction give some idea of the direct increase of cost resulting from them. Some of the intangible results of such changes are losses due to the breaking-up of standard methods of production, labor difficulties resulting from the shifting from piece-work to day-work and back, and late-delivery difficulties with the purchasers caused

Investigation and Interpretation

THE future of America is in the hands of two men, the investigator and the interpreter. We shall never lack for the administrator, the third man needed to complete this trinity of social servants. And we have an ample supply of investigators, but there is a shortage of readable and responsible interpreters, men who can effectively play mediator between specialist and layman. The practical value of every social invention or material discovery depends upon its being adequately interpreted to the masses. Science owes its effective ministry as much to the interpretative mind as to the creative mind. The knowledge of mankind is advanced by the investigator, but the investigator is not always the best interpreter of his discoveries. Rarely, in fact, do the genius for exploration and the genius for exposition meet in the same mind.

The interpreter stands between the layman, whose knowledge of all things is indefinite, and the investigator whose knowledge of one thing is authoritative. The investigator advances knowledge; the interpreter advances progress. History affords abundant evidence that civilization has advanced in direct ratio to the efficiency with which the thought of the thinkers has been translated into the language of the workers.

A dozen fields of thought are today congested with knowledge that the physical and social sciences have unearthed, and the whole tone and temper of American life can be lifted by putting this knowledge into general circulation. But where are the interpreters with the training and the willingness to translate this knowledge into the language of the street?—Glenn Frank, in *Child Welfare Magazine.*

Power-Generation Trend and Possibilities

THE tendency in power generation is toward constantly higher pressures. Five hundred pounds is now common in central-station practice. A single installation is working at 1200 lb., and two are reported as operating at a pressure of 3200 lb.

The mercury turbine has demonstrated its extraordinary efficiency in power generation. Mercury is expensive, however, and the supply is limited. We need, therefore, a substitute for mercury in this connection, and it may probably be found in an organic compound of high specific-gravity and boiling-point and great stability. Diphenyl oxide, which boils without decomposition at 498 deg. fahr., has been suggested.—From an address by Arthur D. Little.

Relation of Commercial to Army Transportation

By Brigadier-Gen. Francis H. Pope, U. S. A.[1]

Transportation Banquet Address

REMARKING that whatever other lessons the World War may have taught it has impressed upon the minds of all that modern warfare by no means pertains exclusively to the military, but embraces the entire activities of a Nation; and that, in warfare of the future, the industrial element of the Country will play a far more important rôle in comparison with the military element than in past conflicts, the author states the sole purpose of the military organization in this Country to be the protection of our National life and prosperity and then analyzes motor-transport's place in the military field, using the high quality of the French development of motor transport as an example of efficiency.

Means of transporting tactical units are enumerated and the refinement of detail necessary in Army transport is emphasized. The formation of the Inter-Allied Motor Transport Reserve is outlined, together with the practices pertaining to the operation of motor transport in combat, in the zone of the interior, and in the theater of operations. Roads, the quantity of motor-vehicle equipment needed, and the types of vehicle adopted are discussed. Emergency conditions that are likely to arise during a national conflict are considered as to their influence on the number of vehicles required and on their design.

An outline of the present motor-transport procurement-plan is given, repair and parts-supply facilities and methods are described, and military operation is compared with commercial operation. The subject of pooling and coordinating transportation is commented upon, as well as that of the commercial application of the pooling principle. Other subjects treated include the coordination of transport facilities and a discussion of the fundamental identity of the mechanical-transport medium.

In conclusion, the author says that when the time arrives in which all forms of mechanical transport function as a coordinated machine, carrying out efficiently the great transportation task of American industry without conflict or economic waste, then there will be no reason for a discussion of the relation of military to commercial transport because they will be one and the same thing.

SCARCELY 10 years ago a talk on military motor transportation would have been regarded by an assemblage of automotive engineers as of merely academic interest and as touching only remotely the everyday life of the professional man in the commercial automotive field. Whatever other lessons the World War may have taught, certainly it has impressed upon the minds of all that modern warfare by no means pertains exclusively to the military, but embraces the entire activities of a nation. And it is a patent fact that, in warfare of the future, the industrial element of the Country will play a far more important rôle in comparison with the military element than in past conflicts.

More than half a century ago one of our great American military thinkers said, "Armies do not make wars, but wars make armies." Or, as it has been put recently by our able Chief of Staff, Gen. Charles P. Summerall,

> It is not the civilian element of our Country that assists the military in time of National emergency, but it is the military that assists the civilian in restoring the peace that the civilian has lost.

It is a well-established fact that the sole purpose of the military organization in this Country is the protection of our National life and prosperity. It is the form of insurance established by our commerce and industry either to avert the dangers incidental to National misunderstandings or to keep to the minimum, in both time and degree, the losses to our National welfare that would be entailed by a great war. It is the organization that has been set up to specialize in the subject of restoring the National peace, which may be lost, through various causes, by industry and by commerce. Therefore, when a military man is asked to speak before an important industrial or professional association like the present one, he should not necessarily deem that a privilege has been conferred upon him, but he should feel it to be a very important duty, as he is rendering a report, so to speak, on that phase of the great National-defense problem with which his audience is most closely concerned, and he realizes that the problem does not concern defense for himself alone, but defense for all who are dependent upon the orderly course of industry and commerce for their well-being and prosperity.

Motor-Transport's Place in Military Field

In these remarks it is therefore desired to bring out the place in the military field occupied by transportation, especially motor transport; the requirements of the American Army in motor-transport equipment in a National emergency of the future; the method by which the Army is proposing to meet its responsibilities therein; and, finally, to set forth the lessons that commercial transport can draw from the experience of the military transport in this field, especially in view of the fact that there is no essential difference between the principles of commercial and military motor-transport. Rapid and efficient transportation is one of the essentials for success in military operations. From the earliest times, that commander has been victorious who had the most efficiently organized transport.

The best definition of military strategy ever propounded is the classic one attributed to the Confederate cavalry leader, General Forrest, "to get the mostest men there firstest." The organization and utilization of transportation for this purpose has been the leading thought of all military commanders from ancient times to the present day. But, during all the centuries of recorded history, actually the first really great advance in military land

[1] S.M.S.A.E.—Chief of transportation service, Quartermaster Corps, City of Washington.

transportation was brought about only during the middle of the last century by the development of mechanical traction in the form of the railroad. After our own Civil War of 1861 to 1865 and the Franco-German War of 1870 and 1871, in which this new type of transport was first utilized on a large scale, all systems of defense in the great nations of Europe were based on the construction of extensive railway nets that were laid out primarily for military and not for commercial reasons.

The utilization of motor transport in quantity is peculiarly a development of the late war. Its employment in that conflict has resulted in that enormous growth of this type of transport during the post-war period that has made motor transport the outstanding industrial development of the present age. This unprecedented increase in a transportation facility has commanded the serious attention, not only of industry and commerce, but of the military student as well. However, the military man has lived through his intensive use of this type of transport and is now in a position to look back over his experience and evaluate its performance, so that he can formulate the principles governing its utilization and their application to various conditions. This is not the case with the civilian who is now undergoing that intensive experience in the commercial field, and who is being too greatly pressed by the daily problems of this extraordinary growth to gain a proper idea of the broad general principles thereof.

French Development of Motor Transport

Of all the nations involved in the World War, the highest development and the most efficient use of motor transport in quantity was attained by the French, and it is to that experience that the military student turns for the principles governing the use of this type of transport. Therefore, a brief sketch of the operation of the French transport is of interest.

In 1914, at the beginning of the World War, the two great classes of military land transport were the railroad and the animal-drawn equipment. However, the subject of motor transport had been given intensive study and provision for its use had been made several years previously by the French. But the great quantity of animal-drawn transport-equipment available, the relative small quantity of motor equipment and the enormous expense of scrapping the former, had an important effect in delaying extensive use of motor transport previous to that time, especially as a military man has a certain hesitation in doing away on a large scale with a well-tried method in favor of a new and untried one.

Therefore, at that time, motor-vehicles were regarded generally as a supplement to animal-drawn highway transport, by being a substitution of a mechanical animal of much greater power, speed and radius of action; that is, motor transport was looked upon as a new development of animal-drawn land transport.

In addition to its utilization for purely cargo-carrying purposes, motor transport was given intensive study as a means of transporting troops in quantity and, during the maneuvers in 1912 and 1913, the transportation of troops by motor-vehicle was conducted on a comparatively large scale. As a result of these experiments, the French, at the outbreak of the war, had organized four automobile groups assigned specially for troop transport. These groups, composed of the Paris omnibuses, were actively employed from the start of the war and received their baptism of fire in Belgium in August, 1914.

These troop-carrying groups were rapidly increased in number by the addition of cargo trucks and, in October, 1914, there was created the Reserve Foch, a collection of motor-vehicle groups whose carrying capacity attained the magnitude of an infantry division.

Means of Transporting Tactical Units

This Reserve was under the exclusive command of General Foch, commander of the northern group of armies in the "race to the sea," who made intensive use of this motor transport during that battle; and, owing to the influence of that great military leader, these motor-transport formations were recognized as an indispensable means of assuring, in connection with the railroads, the transport of great tactical units. It is desired to call particular attention to the foregoing statement, as it is believed to be the first realization of the fundamental principle of motor transport; namely, that motor transport is not an extension of animal-drawn highway-transport but an extension of the railroad.

As more motor-transport equipment became available, provision was made for carrying, not only the infantrymen, but also artillery cannon and caissons, with their draft animals, so that a division could be maneuvered rapidly with all of its combat elements. As an example, on July 17 and 18, 1918, the 63rd French Division, with its artillery, was moved by motor-truck a distance of 104 miles to the vicinity of Soissons, and was enabled to engage in the combat as a unit.

The quantity use of motor-vehicles, not only for cargo carrying but for troop transport, increased enormously as the war continued and it is now one of the outstanding features of military operations. To indicate this growth in troop transportation alone, during September, 1914, about 200,000 men were carried by motor transport, while during 20 days in July, 1918, more than 1,000,000 men were thus transported.

A more detailed review of the utilization of motor transport during the war cannot be given herein, but a study of the details of the operation and management of the motor transport will well repay any large operator of motor-vehicles in this Country.

Refinement of Detail in Army Transport

Many examples, from both American and French experience, could be given to indicate the refinement of detail necessary to carry out this motor-transport work. One illustration, however, will suffice; that of the French troop movement in May, 1918, incidental to the great German offensive in the Rheims-Soissons region. First, control of highway circulation at the front was reserved by the commander in chief, who exercised it through the director of the motor-transport service stationed at French General Headquarters. With each group of armies was an assistant to the director, who was responsible for all motor-transport operation and also was in charge of traffic control in the army group-area. This traffic control was exercised through agencies known as automobile regulating commissions, of which there were three types: circulation, embarkation, and debarkation, which terms sufficiently describe their functions. These formations were composed of transport supervisors, telephone and telegraph operators, military police, repair organizations, road-maintenance engineers, and similar personnel. In a word, these regulating commissions were analogous to the division superintendents, train dispatchers, telegraphers, station agents, maintenance-of-way men and the like of a railroad system in which stone replaced steel and of which the director of the motor-transport service was the general manager.

The motor-transport service, with all other services at

the French General Headquarters, had prepared plans looking to eventualities, and the plan put into execution on the evening of May 26, 1918, had been prepared 2 weeks previously. It was divided into three parts. Paragraph 1 provided for the designation and preparation of the requisite motor-transport operating groups, and for orders for certain regulating commissions. Paragraph 2 provided for the stationing of the various regulating commissions in the sectors in which movements were to be made. Paragraph 3 provided for the specific organization of the highway circulation for all elements, motor-vehicles, animal-drawn equipment, tractors and foot troops.

The transport began on the morning of May 27, and in the succeeding 7 days the infantry of 33 divisions and the artillery of 3 divisions were moved by motor-truck. From that date throughout the continuance of the attack these transport groups were busily engaged in the transportation of food, ammunition and supplies.

Consider the mass of detail that had to be provided for in these operations: the movement of each automobile group to the point at which troops were to be entrucked, movement to the point where each group would enter the main highways, its course on such routes, its arrival at the detrucking point, and its return to a new location to pick up another load. Visualize the highways in such sectors with the congestion of marching troops and normal supply-operations, and with this large troop-transport movement interjected therein. Consider the labor entailed in the traffic control, road maintenance, repair of bridges and similar structures, and removal of disabled trucks and vehicles. Think of the measures that had to be anticipated relative to terminal facilities, gasoline replenishment, feeding of operating personnel, and the many other incidentals arising in this intensive movement. To any operator of motor transport this will give some idea of the perfection of the transport organization which made possible, with scarcely a hitch, the carrying out of such movements as a normal part of the motor-transport operations.

Inter-Allied Transport Reserve

Immediately upon the appointment of Marshal Foch as Commander in Chief of the Allied Armies, the question of pooling all the resources of the different armies was taken up, and as a logical consequence came the formation of the Inter-Allied Motor Transport Reserve, a large group of operating units under the direct control of the commander in chief himself. At the time that this Inter-Allied Reserve was formed, it was well said that "the war of effectives has terminated and that the war of transport has begun." In this warfare of movement it would be necessary to bring to the combat lines, rapidly and by surprise, important forces ready to go into action. The railroads might be too far to the rear or not of sufficient capacity for the simultaneous transport of both troops and supplies. If the troops were forced to make a march of several days, the effect of surprise, as well as the follow-up, would be very difficult to secure. Therefore recourse must be had to motor transport to carry out this maneuver, and the employment in mass of motor transport must be looked for.

From this hasty glance at the utilization of motor transport in military operations, it can be understood readily why motor transport has been termed the "regulator of the battle." Its function will be to feed the front of attack with men, cannon, ammunition, food and materials of all kinds, and at the same time to evacuate the wounded with a rapidity heretofore unattainable.

In analyzing any great offensive, it is patent that the motor-transport facilities will not be used for the same purposes all the time. First, all such transport will be utilized in bringing up large supplies of ammunition, food and materials in preparation for the offensive. Then the troops are brought up, followed by supplies of various kinds. The offensive starts. Great numbers of wounded must be evacuated; reserves must be brought up, of both men and materiel. The offensive ceases. Men and materiel must be evacuated.

Motor Transport in Combat

At this time, it may be that an offensive is planned on another part of the front. All these motor-transport facilities must be diverted and utilized in this new locality. If the offensive be followed by an advance, the greater is the need for the coordinated use of this mass of motor transportation. Therefore, it is an evident conclusion from a study of transportation in the World War that motor transport is destined to play in great part the strategic rôle that has been peculiarly the province of the railroad since that form of transport first became a factor in modern warfare. But motor transport can bring to this rôle in many cases more speed and flexibility. In fact, these two forms of mechanical transport supplement each other and, in warfare of magnitude, must be considered as complementary systems.

The great strategic rôle of motor transport as a troop-carrying agency has been stressed in the preceding outline because its utilization for that purpose is the outstanding transportation development of the late war and is one that is little realized outside of military circles. The use of motor transport as a cargo-carrying agency, in both the front areas and along the lines of communication, is generally well known.

Transport in Zone of the Interior

In any war, the operations of the military establishment can be divided into two categories: that in the theater of operations, where the army is operating, and that in the rest of the National territory, which the military man calls the zone of the interior.

In this latter territory all activities are devoted to exploiting and developing the National resources in men and materiel required for military purposes, so as to supply the means required by the commander of the field forces, at such times and in such quantity, manner and form as will assure him the freedom of action necessary for the accomplishment of his military mission.

In the zone of the interior, the handling of motor transport differs in no way from commercial operation, with the possible exception of the training activities of the transport personnel so that they can perform their duties efficiently when operating with the army. In fact, it may well be the general policy to rely on commercial transportation to perform transportation work in the majority of army installations in this territory. Therefore, the subject of military transportation will be confined to the "theater of operations"; that is, to the territory in which the field forces are operating actively.

Transport in Theater of Operations

The transportation system in a theater of operations may include all the following means: rail, highway, water and air. Rail transportation is usually the controlling factor in military operations. All other means of transportation are usually supplementary thereto.

The adequacy of the supply and evacuation system is primarily dependent upon the efficient organization, ad-

ministration and operation of the available means of transportation. Efficiency of operation requires, first, that there be one and only one agency charged with the operation of each of the several means of transportation; second, that there exist a centralized control of all transportation agencies to secure their proper coordination; and third, that the operation of the several agencies be decentralized to secure flexibility and mobility.

Military motor-transport in the theater of operations includes every phase of motor-transport operation, as to type of cargo, kind of movement and character of roads, that can be found in any commercial-transportation field. In the back areas, around the base depots, ports of debarkation and similar installations, and along the lines of communication, it is used for mass cargo and troop hauling; in the forward areas it connects the railheads with the troops and brings supplies of all kinds to the front lines, carrying back the sick and wounded as well as used and surplus materiel of all kinds. In the great offensives it is used for the transport of combat units and materiel, as already described.

In the areas around the depots and supply installations, operating conditions are those of our large industrial centers; along the roads to the front, intercity heavy trucking; in the vicinity of combat troops will be encountered conditions found in the oil fields of Oklahoma and Texas, while farther toward the front reliance may need to be placed on that well-tried type of transport whose motive power is furnished by that grand old hay-burner, the army mule.

In a normal theater of operations, it has been estimated that approximately 50 per cent of the terrain will have fairly hard surfaced roads; 35 per cent will have passable roads or such as can be kept in that condition by the road-maintenance organization of the army; and approximately 15 per cent will entail what may be termed cross-country work. Therefore, there must be a type of motor-vehicle for army use that will conform to each of the above conditions, but it would be very uneconomical to have all types capable of operating over the worst conditions, as the vehicle suitable for cross-country work would be unsuitable for work over hard roads, or at least very much less efficient than another type of vehicle.

Only a relatively small proportion of the motor-transport operation is required on terrain devoid of roads, as a modern army of any size, with its varied and mechanized equipment, cannot operate without roads and necessarily includes a large organization devoted entirely to road construction and maintenance. But much of the transport equipment that will ordinarily operate over good roads must be capable also of operating where fair roads do not exist, as it will be impracticable to segregate that class of transport for that special kind of work. This accounts for the large proportion of vehicles of the four-wheel-drive type selected for military purposes.

After this description of the various conditions of military motor-transport operation, as to both kind of work and character of roads to be expected, the type and quantity of the motor-vehicle equipment needed to carry out the Army's requirements will be touched upon briefly.

The essential basic principle to be followed in determining the kind of equipment is to limit to the greatest possible degree both the varieties of make and of model of vehicle. Standardization of vehicle equipment is a prime essential in military motor transportation. The close interrelation between operation and maintenance, or "service," as it is called in the automotive industry, is too well known to need any mention here. In a theater of operations, the Army will not find the Country dotted with service stations and stocks of supplies for the various motor-vehicles that it operates. It must establish its own service system, must set up its own stock depots, and must operate its own repair installations. The spare-parts-supply problem is sufficiently difficult at best; but it would be insoluble were the Army to be equipped with many different models of vehicle. The experience of the late war is not needed to demonstrate this fact.

BRIGADIER-GEN. FRANCIS H. POPE, U. S. A.

The fleet of a commercial-transportation company operating on a large scale may well be made up of groups, each operating in a particular locality with each group composed of vehicles of a limited variety of makes, dependent upon the character of the locality. This is by no means the case with the Army.

In military operations, contingencies and changing conditions are constantly arising, which make flexibility an essential in military organization, and this applies with full force to the question of variety of motor-vehicle equipment. Transportation equipment must be such as to permit the greatest possible measure of interchangeability.

BODY VARIETIES MUST BE RESTRICTED

In selecting types of vehicle, the chassis and the body equipment have been considered separately. A chassis can carry a cargo of a certain weight or dimension, irrespective of its exact nature. The body equipment must take care of the latter. In accordance with the principle of standardization already set forth, the variety in body type is also restricted to the minimum. So far as possible, bodies must be of the general-cargo type, capable of carrying both ordinary material and, with the addition of portable troop-seats, soldiers with their equipment. It would be very nice if a fleet of motorbuses could be kept for such troop hauling; but such a collection of vehicles would be useless for cargo purposes and, as already stated, such collections of military vehicles must be capable of performing a variety of transportation work.

Types of Motor-Vehicle Adopted

Based upon the considerations outlined, the following types of motor-vehicle equipment have been adopted for transportation purposes:

(1) *Automobiles.*—Both 5-passenger and 7-passenger
(2) *Truck Chassis.*—Capacity, ¾ to 1 ton. These will be fitted with cargo bodies for light delivery-work as well as light repair-work, with passenger-carrying seats for use with motorized organizations and with ambulance bodies for the Medical Department
(3) *Truck Chassis.*—Capacity, 1½ to 2 tons. Equipped with cargo bodies. These will form the normal equipment for divisional trains, the work of which usually is in the front areas, and, with the addition of troop seats, will be suitable for troop hauling. Certain vehicles for technical use of the various services will be provided by equipping this chassis with a special-type body
(4) *Truck Chassis.*—Capacity, 3 to 5 tons. These are the vehicles for normal use with corps and army trains and for general-transport purposes. A certain proportion of the heavier type can be equipped with special bodies so that they can be used for technical purposes, such as machine-shops, photographic laboratory, gasoline tanks and similar special uses
(5) *Truck Chassis.*—Capacity, 1½ and 3 tons. Four-wheel drive. This type is needed primarily to furnish tractor trucks for motorized artillery formations, and also for use over country devoid of roads and that would be impassable for the two-wheel-drive type
(6) *Chassis.*—Six-wheel, of the four-wheel-drive type. This type is being developed by the Army, primarily as a means of obtaining increased speed for heavy loads and decreased destructive effect on the roads. But, in addition, this type possesses a certain ability for cross-country work and operating under conditions calling for a four-wheel drive. The use of pneumatic tires, made possible by distribution of load over three axles instead of two, and the increased rate of deceleration due to a four-wheel braking-system, effect this increase in speed which is a factor of special importance in military use. The use of this truck in mass operation will permit more than doubling the practical speed over that of two-wheel-drive trucks, will require less road space per ton of pay-load to be transported, and will require less operating personnel per ton of cargo. The effect of this on traffic congestion will be apparent. The very much less destructive effect on roads is as important in military operations as increase of transport speed and capacity. There is also the distinct advantage of the rapid transport of troops in quantity

A consideration of the body types for the foregoing military vehicles would involve too much detail and lead too far into a side issue of the rather extended subject that this paper is intended to cover.

Number of Vehicles Required in Emergency

Having determined the types of vehicle, the quantities that it will be necessary to procure in case of a major National emergency are figured directly from the general War Department plan for such an emergency. The computations are based on the troops that are to be raised, the tables of equipment therefor, the rate at which troops will be called out, and the estimated replacement of equipment over a predetermined period. These computations form the basis of the Motor Transport Procurement Plan that has already been developed in great detail.

There seems to be a well-defined idea in some quarters that, because the automotive industry has become the largest individual industry in the United States, the Army motor-transport procurement-problem is no problem at all, that development of types can be left to the industry, and that in a National emergency the normal output of the industry will meet all Army needs. This opinion would appear to be well founded if based merely on a comparison of total Army requirements with current production figures. For instance, the approximate Army requirements during the first year of an emergency like the World War call only for approximately 0.5 per cent of current passenger-car production and 31 per cent of current motor-truck production.

However, when certain vital factors are taken into consideration and these general figures are subjected to analysis, the fallacy of any such conclusion will stand out clearly. In the first place, during a major National emergency, a very large percentage of the productive capacity of the automotive industry, as well as the allied sources of supply therefor, will be diverted to the manufacture of ordnance and air equipment, such as armament, artillery and ammunition. Only a portion of such productive capacity can be retained for the manufacture of motor-vehicles for civilian and for military needs. This is but one element in the so-called industrial mobilization that has been under intensive study and planning by the Assistant Secretary of War, upon whom responsibility therefor is placed by the National Defence Act. This subject, in certain of its details, is well known to the production personnel in the automotive industry.

Further, on analyzing the general figures already indicated, the following facts appear. The military requirements for passenger-cars for the first year of a major emergency are but a small fraction of the output of any one of several manufacturers. Therefore, this type of equipment presents no problem and can be dismissed from further consideration, as will also the question of trailers and motorcycles. But it is a very different matter with motor-truck equipment. The Army requirements for such vehicles indicate that 20 per cent of the total is for capacities up to and including 1 ton, and 80 per cent for greater capacities; but, in commercial production, 80 per cent is in capacities up to and including 1 ton, and 20 per cent only for greater capacities. In addition, this commercial production is made up of approximately 120 makes and includes nearly 640 models. Therefore, the military problem is in the procurement of medium and of heavy motor-truck equipment, excluding the so-called light delivery-type, and this problem becomes more clearly indicated when the four-wheel-drive type is considered separately from the type of vehicle which two-wheel-drive.

Motor-Truck Requirements

For the two-wheel-drive type, Army requirements are more than 50 per cent greater than commercial production, which includes more than 160 different makes. The requirements for four-wheel-drive equipment are practically confined to the military, the Army program calling for virtually 15 times the commercial production of this type. There naturally arises the question as to the need for this four-wheel-drive type for the Army if commercial demand therefor is relatively non-existent. The reason is directly related to the question of bad roads or lack of any roads in certain portions of the territory over which the Army will be forced to operate.

In addition, there is the need for this type for use with motor-drawn artillery formations.

In the commercial operating field, the enormous increase in mileage of improved roads, especially in those sections justifying commercial operation, naturally has caused but a very limited demand for the four-wheel-drive type. However, this does not by any means alter the situation with the Army, which must have a certain percentage of its vehicles suitable for operation where the existence of good roads cannot reasonably be expected.

Essential Requirements of Design

In selecting the particular make or design of each of the types mentioned, consideration must be given to the requirements of a car for military use. The essential requirements are that it be of rugged construction, extreme dependability, and made up, to the greatest possible degree, of standard units and assemblies; in other words, it should contain the minimum number of units of special design peculiar to the particular make. The restriction as to the varieties of make and of model already has been stated.

It is believed that the foregoing considerations will indicate the existence of a motor-transport procurement-problem, especially as its solution will need to be worked out in conjunction with all other procurement problems confronting the military when a National emergency arises. Therefore, in constructing this motor-transport procurement-plan, based on the requirements already outlined, the automotive and the allied industrial fields had to be surveyed to determine makes and models of vehicle equipment; allocation of productive capacities of specific plants had to be obtained; and methods of operating the plan had to be drawn up. All this had to be fitted into the great industrial mobilization plan under the coordinating power of the Assistant Secretary of War so that, in time of emergency, the procurement of all military supplies can be carried out on a businesslike basis and the unfortunate experience of the World War in that respect obviated so far as humanly possible.

Motor-Transport Procurement Plan

The motor-transport procurement-plan, the details of which are now in process of completion, contemplates that the procurement of all motor-transport chassis shall be carried out by the Motor Transport Division under the supervision of the chief of the transportation service. On the outbreak of the emergency, procurement offices will be set up in one of the automotive industrial centers, and the officer in charge thereof will be responsible for the carrying out of the procurement plan. He will be provided with the necessary number of assistants and the inspectors at the various plants will be under his supervision. To obviate congestion at the plants, all vehicles accepted each day will be moved to establishments called reception parks, located away from the congested industrial areas. The sites for these parks have been selected tentatively. At these establishments, vehicles are to be registered, equipped for service, and either dispatched by rail or road to the points where required or held for issue to organizations, detachments or individuals sent therefor.

The procurement plan, as well as the various detailed plans necessary to carry it into operation, have been worked out to the point that the bills of materials and dates needed have been calculated, the personnel to operate the plan has been selected tentatively, the procurement and training of the organizations to operate the reception parks and the dates on which they are to report are specified in the general mobilization plans and the organizations to which vehicles are to be shipped, points of shipment and dates of delivery have been tabulated. While all these plans will be constantly in a state of revision, this statement will give an idea as to how far this Country has progressed from the conditions that prevailed in 1917, and will give an indication that the element of our National organization charged with the defense of the Country is not lying down on its job.

The basic operating organizations of these military vehicles are the motor-transport companies, which are grouped into division, corps, Army, and line-of-communication trains, each with a supervisory overhead similar to a battalion headquarters. The operation of motor transport in the theater of operations is under the supervision of motor-transport officers attached to the various divisional and higher headquarters. But a description as to its method of operation is entirely too extended a subject to be taken up at this time.

Repair and Parts-Supply Facilities

Concurrently with the vehicle-operating formations, there must be a maintenance or service organization. Motor-transport repair and parts-supply facilities are divided into three general classes—service parks, overhaul parks and reconstruction parks—that function as a progressive system of repair from front-line positions to the back areas, graduated for rapid evacuation and repair at places best fulfilling all conditions attendant upon the nature of the repair.

Service parks are primarily designed to make light repairs not requiring too great an interval of time or heavy equipment, and are located wherever there is a motor-transport activity. The extent of repairs to be undertaken and the time element depend on local circumstances and must be determined by the particular elements in each case. Service parks are either mobile or immobile, depending on the character of the formations they serve. A mobile differs from an immobile shop only in the fact that in the former the machinery is mounted on vehicles.

Overhaul parks are primarily for overhaul and repair of units and vehicles requiring work of a nature beyond the repair facilities of a service park. Their work is much more extensive repair-operations, requiring heavier machinery and longer periods for completion. These are, therefore, of a semi-permanent nature. To give them the greatest mobility possible, machines are mounted on skids to facilitate removal and installation in a new location.

A reconstruction park is intended primarily to make the major repairs, to undertake the reconstruction of vehicles and assemblies, and also to do the manufacturing production-work necessitated by the various emergencies of military operations. An important element is its salvage section for the classification, disposition or remanufacture of all such motor-transport materiel. From its nature, it must be practically an immobile establishment.

The personnel for repair and service work is organized into motor-repair sections, companies and battalions.

The distinction between the character of work to be performed in the overhaul park and the reconstruction park must be determined by the particular conditions in the military operations. The overhaul park is in reality the link in the supply and repair system to give it that flexibility essential in any military organization. The details of the Army maintenance system will not be touched upon herein. To give an idea as to the extent

of these operation and service requirements, it may suffice to mention that the motor-transport equipment for one field army of 300,000 men would occupy 220 miles of road in convoy formation, and, if all were parked in one place, would require a field of 160 acres, or one-quarter of a square mile.

Military and Commercial Operation

With this general description of military motor-transport and its place in military operations, the question naturally arises as to the difference between the principles governing its operation and those of commercial transportation. There is no difference between the principles of military and commercial operation. The basic principle is to get the maximum transportation output from a given vehicle equipment. All other operating principles are deduced therefrom. However, there may be an apparent divergence in the application of these principles in military and commercial practice. This is due to the fact that military success is measured in terms of results now and not in terms of industrial efficiency and perfected niceties possible in commercial pursuits. Therefore, a proper plan of organization in military life must be one that, while giving "results now," will be capable of giving all possible consideration to efficiency as judged by industrial standards. In military operation certainty must outweigh considerations of economy. The delivery of a cargo of goods or passengers may be delayed without any very disastrous results to the commercial life of an industrial organization, but such a delay in military operations may result in a lost battle and a lost war. In military life, all other considerations must give way to certainty of action.

Another essential difference between military and industrial organization comes from the fact that an industrial organization is designed to supply a more or less known demand for a certain fixed product over a definite territory and with a fairly fixed location for its producing elements. On the other hand, a military organization has to meet a wide variety of conditions which cannot be anticipated and concerning which advance information is rarely available. It must be able to shift rapidly its scenes of activity and to meet a wide range of load conditions. This requires that any scheme of military organization have a great flexibility, even though it may not be able to meet normal full-load conditions as well as would a purely industrial organization. For instance, in the transportation field, it often has been suggested that the Army might well study and copy the methods used by a large circus in making its summer itinerary. But nothing could be more widely apart than the standardized moves of a circus, with fixed equipment and fixed daily schedule, and the varied and unforeseen movements of troops in active operations, no two of which are made with the same equipment, same loads, or under the same conditions.

An illustration of a difference in the detailed application of a principle in commercial practice from that in the military is in cost-accounting methods. In commercial life, where the production of a dividend is the basic object of the organization and the standard of measurement of its success, cost accounting is a prime essential and the necessary overhead therefor is accepted as the price that must be paid. All efforts are directed, not at doing away with this overhead, but merely in reducing its expense. In military life, what may be termed productive labor is confined to the soldier on the firing-line. Every other man in the Army must be charged to overhead, just as necessary and essential, it is true, as the non-productive labor in an industrial organization. The necessity for keeping to the irreducible minimum the percentage of military man-power behind the firing line is too evident for comment here. But when everything back of the man firing a weapon must be considered as overhead, there can readily be seen the priority on such a list that can be given to cost accounting, no matter how important such a subject may be in purely industrial life. This is especially the case inasmuch as there is no monetary standard of measurement with which to measure success in military operations.

In military operations, a result obtained in time for its efficient effect by the expenditure of $1,000,000 will be cheap at the price. An expenditure of $1 for the purpose after the time that it can be effectively utilized is a waste of money. Economy of operation is essential in military life but it is measured in terms of economy of effort, personnel and equipment, and not directly in terms of dollars. Therefore, it can be seen that rarely in military life will it be practicable to put into effect the elaborate and detailed cost-accounting systems that are essential in a commercial organization.

Pooling and Coordinating Transportation

But in two of the more important applications of these transportation principles it is believed that the Army, due to its experience in the intensive use of motor transport, is far ahead of commercial practice. These are, first, the system of pooling transportation, and, second, the coordination of all means of transport. The pooling of transport means simply the placing of all vehicles used for general transportation purposes under one authority and the assigning of transportation from this particular pool to meet the actual needs in each specified case. Pooling of transportation means simply unity of control or, as it has been termed, "pooling of effort." This principle was officially recognized by our Army only after the World War, and even then but in a general way. During the existence of the American Expeditionary Force in France, motor-transport facilities were assigned to combat divisions and became integral portions thereof. All efforts to have this transport pooled under corps and Army commanders were without avail, and only in the rear portions of the territory, in what was known as the Services of Supply, was the pooling principle put into operation.

The practice of permanent assignment of transport to various units, by the way, was directly opposed to the French system, which from the start was based on the "reserve" idea, that is, control by the high command over large groups of transport, allotting only temporarily to combat divisions and similar units such transport facilities as the needs of the moment might demand. In our service, the reluctance to follow this principle undoubtedly arose from the obsession that a motor-vehicle is simply an improved type of animal transport. The well-accepted principles of animal transport, based on its inherent qualities, justify fixed assignment to individual military units. Had there been recognition of the principle that motor transport is inherently a development of the railroad, the condition which prevented any adequate return from the immense mass of motor-transport equipment with the American forces would not have resulted.

Commercial Application of the Pooling Principle

Let us now consider what bearing this principle of pooling military transportation has on any phase of commercial operation. In cold, hard terms it means simply that the operation of small motor-transport fleets

for general transportation business is economically unsound in any logical transportation scheme, and that the day cannot long be delayed when all such operation will be grouped into large transportation corporations, operating over definite territory of considerable extent.

This proposition can also be deduced by analogy from railroad experience. It was not so very long ago that the New York, New Haven & Hartford Railroad system consisted of a congeries or aggregation of small lines, and, undoubtedly, the majority of those in this audience made their first trips between Chicago and New York over a rail line owned by more than one distinct railroad company. In fact, the memory of those times still lingers in the local names by which the various divisions of the great railway systems are known.

In addition to the economic necessity for curtailing excessive and unhealthy competition for the transportation revenue that may be available in a given territory, there is another factor that will bring about this consolidation. This is the economic necessity, from a transportation operator's viewpoint, for establishing his own repair system so that his operating revenue may not be decreased by the profits of an independent repair organization to which he may contract his jobs. This condition applies to organizations in the transportation business, but not necessarily to all operators of motor transport, such as department stores, building contractors and the like, whose transportation is simply incidental to their main line of work. However, it will apply to any contractor of transportation, whether he be in public-service passenger-work or in the general trucking business.

Coordination of Transport Facilities

A second great point of difference between military and commercial transportation is in the application of the principle of the coordination of transport facilities. As mentioned previously, in military life all forms of mechanical traction, on land, on water, or in the air, are operated as one great transportation agency, all of whose elements function as the cogs of a great machine. A coordinating authority apportions to each type the transportation load according to the changing conditions that exist, so that both certainty of action and economy of effort may be assured. In present commercial life this is by no means true. It seems that, generally speaking, each type of transport has been seeking its profit by trying to get for itself the greatest possible portion of the National transportation expenditure, and not by taking that to which, from an economic viewpoint, it is logically entitled, and thus reducing its operating expenses to show a proper margin of profit.

Undoubtedly this condition is changing, as there is much discussion in the industrial world today as to the proper sphere of action of each type. But, judging from a perusal of the many papers presented on this subject, from both the railroad and the motor-transport viewpoint, the fact stands out that each writer looks upon his particular type of transport as something distinct and entirely different from any other form of mechanical traction. The motor-transport industry still holds to the tradition of the animal-drawn transport which it has supplanted on the highways of the Country, but has not realized that it has placed thereon a type of a fundamentally different character. The railroad man sees in the motor-vehicle only the old buggy and the old horse-drawn dray. Even when he drives what to his mind is his mechanical horse and he is held up at a street intersection by a traffic signal, he does not connect that red light with the semaphore on his rail line, or his parking place with the station siding.

Fundamental Identity of Mechanical-Transport Mediums

Neither the motor-transport man nor the railroad man can see the forest on account of the trees. The former, looking at a railroad line, cannot see the stone on account of the rails, and the latter, motoring along a highway, cannot see the rails on account of the concrete. In glancing at an airplane in the skies, neither can see either rails or stone, and both have long ceased to regard the stream flowing along our inland waterways as anything more than the element to which our legislators have relegated the great National thirst. It probably will be said that all this may be very fine as a generality but that it is a very different proposition to evaluate the economic details of any such coordination of transportation, and that this intricate subject is one to which much earnest thought is now being given. This is very true, but it is believed that this work will be rendered far simpler, easier, and more expeditious if based on realization of the fundamental identity of all forms of mechanical transport. Of all the financial enigmas perpetrated on the American public, there is none more complex than the subject of railroad tariffs. No one knows this better than the Army, for, in addition to all the intricacies confronting the civilian, it has the ones of free land-grant and 50-per cent land-grant routes, equalization agreements, railroads indebted to the Government, and many other such features.

One of the full-page advertisements published in many of our popular periodicals shows a clean-cut young man resting one hand lightly on a desk, with the other hand pointing through a window where in the distance may be seen motor-trucks, railroad trains and fleets of ships graphically displayed under the caption "Become a traffic expert." Send for the literature from the correspondence schools responsible for this picture and you will find that this ambitious title of traffic expert is another name for rate clerk.

While there are many factors that have caused this very complex system of tariffs to be imposed on American railroads, it seems that the solution of economic questions affecting rail and motor transport should not be difficult for those experienced in the financial side of rail operation, if approached from a proper viewpoint. The only great fund of experience in the application of mechanical traction to land transport comes from the operation of the railroads during the hundred years of their existence in this Country, including not only the application of steam and electricity as motive power, but also of gasoline. With the realization that an internal-combustion engine is simply another form of motive power applied to mechanical traction, and that the vehicles have the ability to operate over some other material than steel rails, the railroad man, from his detailed knowledge, or the motor-transport man, from a study of railroad experience, should be in a position to work out the proper coordination of these two types of mechanical land-transport and their proper relation to our inland water-transport, and be prepared to welcome into this transportation company on rational terms of partnership that new form of mechanical transport whose wings we now hear flapping in the air.

Paraphrasing the words of Benjamin Franklin, if all kinds of transport do not hang together, they may not all hang separately, but certainly some of them will. The experience of military transport in the World War has

proved conclusively that coordination of transport is not only practicable, economical and efficient, but that it is inevitable. It was forced on the military by the necessity for economy of time, force, and effort, but its results were economy of money. It took several years of intensive warfare for military men to appreciate this fact, and it is not to be wondered at that in industry and commerce there seems to be so much difficulty in realizing this proposition, although the exigencies of the present economic struggle were undoubtedly speeding this question to a proper solution.

When the time arrives in which all forms of mechanical transport function as a coordinated machine, carrying out efficiently the great transportation task of American industry without conflict or economic waste, there will be no reason for a discussion of the relation of military to commercial transport, as they will be one and the same thing.

Detonation

CARBON is a good absorber of heat, but its heat transmitting capacity is more than 100 times less than that of iron. Hence it heats up more quickly than iron, and it is regarded as the ideal radiator of energy. Thus it is probable that the role of carbon as a detonation inducer is that of activation rather than actual increase in compression ratio.

The spontaneous character of the energy release in detonative combustion is due to the absence of cooling effect as compared with progressive propellant inflammation. In the latter a balance is struck between energy release by combustion and cooling by energy absorption in chemical activation or as heat loss to walls.

Detonative combustion is distinguished by an external supply of activating energy and absence of quenching of combustion by cooling. Hence energy release proceeds unchecked, and this results in practically simultaneous ignition of a densely packed combustible mixture.

Simple Mechanism Produces Complex Results

The knock is a consequence of the projection of particles in the attempt to equalize pressures, but there would be no noise if this expansion could not take place, either because of a driving back of the contents or a bursting of the container. The mechanism of detonation is thus simplicity itself, although the consequences of the action are infinitely complex.

The atoms at a hot spot emit activating energy which is absorbed selectively by the various constituents of the gaseous combustible. Whenever the vibrations induced in the binding electrons are sufficient, the linkages between atoms are broken, and activated atoms, or ions, are set free. Chemical reunion of ions is attained with an even greater intensity of energy liberation, and this local burning causes combustion to spread with ever-increasing rapidity. Detonative combustion signifies the absence of any check by cooling until the detonation blast signalizes the sudden expansion which occurs during a disruptive discharge of energy.

Fundamental Laws and Detonation Theory

In promulgating a theory of detonation it is customary to appeal to fundamental laws, which procedure has the advantage that mathematical analysis invariably *proves* the theory advocated.

The reason for this is that any dynamical system postulates inertial mass and change in its motion by an accelerating force. The stages of philosophical thought have led from perpetual, molecular, motion in an immaterial frictionless ether to vibrating electrons absorbing corpuscular energy in the form of quanta. The existence of energy in space has led to such impossible ideas as action at a distance, gravitational and electrical force-fields. These credit space with the "potential" energy which disappears and reappears during any physico-chemical transformation.

In all mathematical treatment this system of debit and credit between kinetic energy of matter and hidden potential energy in space permits the theorist to beg the whole question in the initial assumption as to the mechanism of activation. Thus, temperature corresponds to collisions in kinetic theory. Free energy is correlated with gain or loss of entropy in thermodynamics, which entails not only the amount of caloric energy, heat, supplied, but also the temperature at which it is received. The variable quantum fits in with physico-chemical reactivity because it postulates the pre-existence in space of the requisite quanta.

Energy and Matter Believed Identical

The modern trend of scientific thought is that energy and matter are ultimately identical, and this agrees with a conception that these are different types of motion of and in an all-pervading ethereal medium. On this basis the electron and atom possess inertia due to their rotation hindering the flow of streaming radiant energy.

Furthermore, though matter and space may be separated for convenience in mathematical manipulation, the fact remains that they are indissolubly joined together in that action and reaction which constitutes Newton's Third Law. This is the basis of balanced thought whereby mathematical science eliminates metaphysical imagination. In proceeding to an examination of detonation theory, there is an inestimable advantage in not being bound by convention to any particular aspect of science, inasmuch as practical considerations alone have been used in dealing with all the various phenomena attendant upon detonative effects.—From an article by W. A. Whatmough in *The Automobile Engineer*.

Developments in Cylinder Grinding

By M. C. Hutto[1]

Production Meeting Paper *Illustrated with* Drawings and Photographs

AN illustration of the fact that refinement in the production of one mechanical part demands improvement of all related parts is given in the case considered by the author, in which the manufacturing of more accurate pistons necessitated better cylinders. Cylinder barrels ground with abrasive wheels rotated at high speed had many disadvantages. The problem was manifestly to develop new grinding-methods which would have four distinct improvements; namely, greater accuracy, greater speed, better finish and lower cost.

Cylinders lapped with abrasive compound had pleasing finished surfaces and suggested possibilities in that direction. Expanding lead-laps subsequently were designed which were encouraging but had many drawbacks. These early experiments were very important as they revealed the basic principles employed today. Errors were studied and corrected. Improved grinders were then manufactured and released to the automotive industry. These were of crude design but their performance was remarkable at the time. Actual use in production and service fields necessitated changes to suit the work, the equipment and the operator. Corrective measures resulted from data submitted by the operators.

Acceptance of this new grinding-method was slow at first, as it appeared radical, but it is now used by 85 per cent of the motor-vehicle builders. Grinders recently developed have surpassed in performance the expectations of the designers. Future developments rest with the public. Better automobiles will be demanded and the car builder will ask for better grinders. Research laboratories are working now to meet the inevitable demands of the future.

REFINEMENT in the methods of producing one of several related mechanical parts necessitates improvement of the manufacturing methods employed to produce the remaining parts. This fact is more true of scientific and engineering advancement than it is of any other advancement. It reminds one of a line of soldiers, rookies, all fired with ambition to excel. First one and then another forges ahead of the line. This superabundance of determination has no place in military maneuvers; but the same spirit, when applied to research, brings us to the present progressive condition of industry, where advanced engineering principles are incorporated in commercial products.

Going back a few years, we find a man working to produce a better piston. According to the standards of the time, he succeeded. He forged ahead of the conventional methods of producing pistons. His success, however, was recognized only by his being confronted with a new problem for solution. Cylinders could not be finished with a degree of accuracy comparable with that of the piston. Let us study the problem ourselves from there on.

Analysis of the task of developing a new method of grinding revealed two distinct classes of obstacle; (*a*) conditions met in the service field, and (*b*) those encountered in production. In the service division there was the condition of tapered cylinders, shown in the upper portion of Fig. 1. This cylinder, strictly speaking, is not *tapered*, as we all know, but has been worn over-size principally in that portion of the cylinder barrel known as "ring-travel." In the reconditioning field we also met another condition, that of the cylinder worn out of round, as illustrated in the lower portion of Fig. 1.

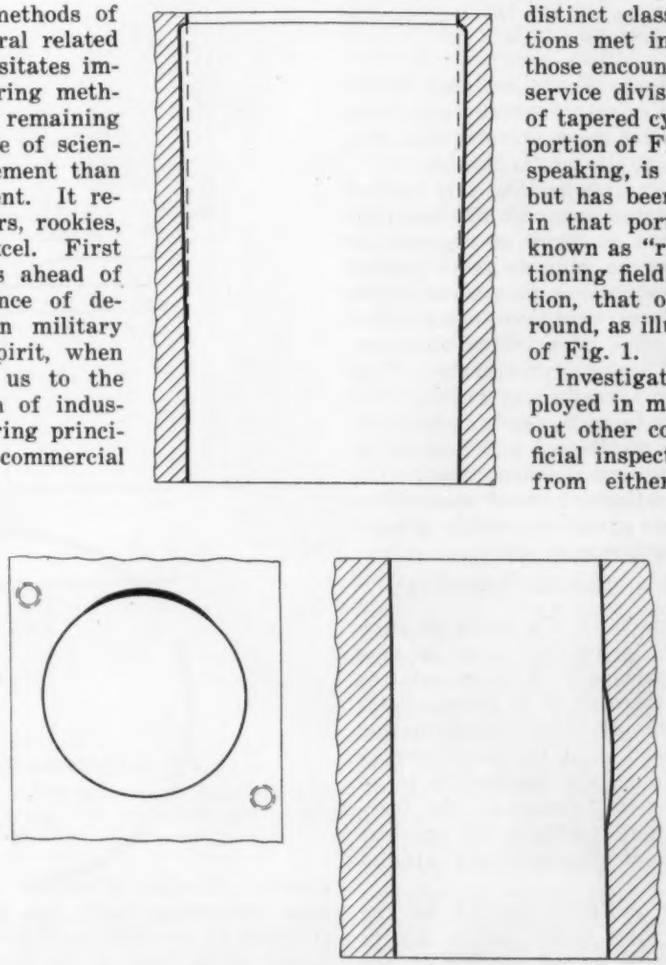


Fig. 1—Cylinder Defects Produced by Wear

The Cylinder Shown in the Upper Portion Was Worn Oversize Principally in That Portion of the Cylinder-Barrel Known As "Ring-Travel." The Lower Portion Illustrates a Cylinder Worn "Out-of-Round"

Investigation of the methods employed in manufacturing plants brought out other conditions which, upon superficial inspection, appeared very different from either of the foregoing. These cylinders were finish ground by an abrasive wheel rotated at high speed and passed slowly through the cylinder, the path of the wheel describing a helix the pitch of which was relatively small, approximately ⅛ in. A magnified section of cylinder-wall ground by this process would appear as in Fig. 2. This cylinder finish was possessed of various disagreeable qualities, not the least of which was one termed "fuzz," for lack of a better name. By this was meant the crest of the helical groove left by the wheel. This fuzz was rapidly sheared off by the piston-rings. While this

[1] President, Hutto Engineering Co., Inc., Detroit.

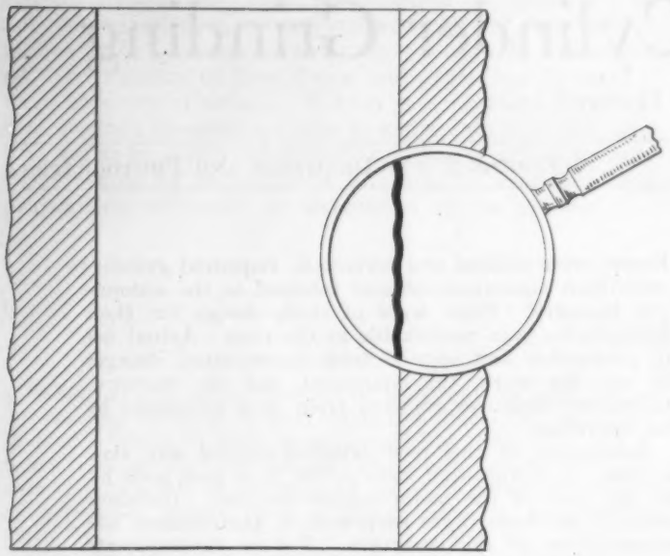


FIG. 2—GENERATION OF "FUZZ" BY GRINDING

A Magnified Section of a Cylinder-Wall Is Shown. An Abrasive Wheel Rotated at High Speed Was Passed Slowly through the Cylinder, the Path of the Wheel Describing a Helix Having a Pitch of Approximately ⅛ In. The Crest of the Helical Groove Left by the Wheel Was Termed "Fuzz," Which Was Sheared Off by the Piston-Rings and the Cylinder Became Worn to Oversize in a Short Time

shearing off the high portions of the cylinder barrel caused numerous troubles, the result which is of most interest is that the cylinder was worn oversize in a very short time, thus shortening the life of the engine.

Perhaps the most important drawback to this method other than that previously stated was cost of operation. The machines were costly, not so much as regards the initial investments but rather as regards their rate of production. With very few exceptions, they were single-spindle machines and in all cases were slow in operation. This necessitated large batteries of grinding-machines, each attended by a skilled and high-priced operator. Time itself, however, was the most costly detriment. The foregoing conditions are those faced by one attacking the problem of developing a new method of grinding which would have none of the foregoing disadvantages. The objective was to design new equipment based upon different principles which would have greater accuracy, greater speed, better cylinder-finish and lower cost.

ANALYSIS OF CONVENTIONAL METHOD NECESSARY

Wherein did the old methods fail? To quote an engineer, "Eternal research is the price that must be paid if American industry is to survive." Experimentation based upon data secured from research, is of greater value than blind endeavor based simply upon determination to reach the goal. To secure such data, the shortcomings of the past methods of procedure are necessarily to be investigated. Recognizing the importance of the foregoing principle and realizing that it affords the shortest and most direct course, study of conventionally ground cylinders was begun.

What was wrong with the cylinder ground by the abrasive-wheel method? The most objectionable quality of this cylinder was the crest or raised portion of the helical groove, called fuzz. Chatter marks, manifested by a series of closely placed indentations, were so noticeable as to be readily recognized even by the layman. Both of these conditions were visible to the naked eye. Use of the dial gage revealed two other conditions; namely, out-of-roundness and taper. These were the facts of the case without explanation. Now let us analyze each case to determine its cause.

Fuzz was caused by the path of the wheel as it generated the helix and also by the fact that the face of the wheel was not absolutely parallel with the axis of the cylinder. The wheel face would develop a convex surface, resulting in the incomplete lapping of one cut with the succeeding one.

Chatter marks were simply the result of uneven wheel-wear. A wheel glazed on one side and free cutting on the other side would chatter. When the glazed surface finally parted company with the wheel, it left this member unbalanced, still further aggravating this condition. Wheels glazed upon certain portions and not upon others were due to the heterogeneous bonding of the abrasive; in short, to unequal densities.

The out-of-round state of cylinder-bores presented a

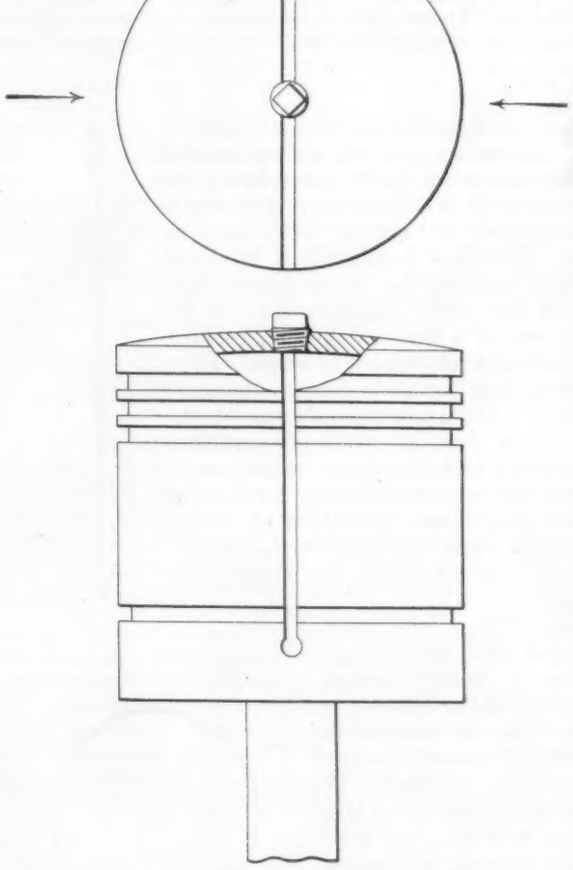


FIG. 3—LAPPING TO REMOVE "FUZZ"

The Essentials of Lapping with a Split Piston Are Indicated. The Piston Was Split into Two Parts and Various Means Were Used to Expand Them

greater plurality of causes. It could result from castings containing hard and soft spots. It could be attributed to previous machining operations. It was even found to be due to the locating fixture. Lastly, the machine and the operator were subject to criticism.

It was discovered that the abrasive wheel would ride over hard spots in the barrel without removing stock. A poor boring and reaming job left stock distributed in

such a way that the wheel was subjected to various cutting loads which could not be counteracted by differentiation of normal pressures. A locating fixture could not be built that would index the block to a position in which the axes of the cylinder and the machine spindle were coincident. Assuming that such a fixture could be produced, it then became impossible to maintain its accuracy. Wear, dirt, loose abrasive, rough usage, warpage and a host of other factors set in to undermine its virtues. The accuracy of the finished cylinder was still further at the mercy of the machine itself. Rigidity of the main and the sub-spindles was of paramount importance. Bending of either resulted in error. Bearings had to be perfect, or as nearly so as it was humanly possible to make them. It was a difficult problem to protect these bearings. Granting all the previous discrepancies to be non-existent, we were still confronted with the human element in the form of the machine operator. If he crowded the job, success was impossible.

Errors Due to Two Causes

A remarkable phase of this investigation came to light when these causes were cataloged for further study. As is so often true, it was found possible to divide these causes or perhaps, more correctly speaking, these occasions for errors into two groups, each of which fell under faulty principles or under principles erroneously applied. The principle governing one group was that employed in the method of cylinder generation. The other group was commanded by the improper application of an abrasive.

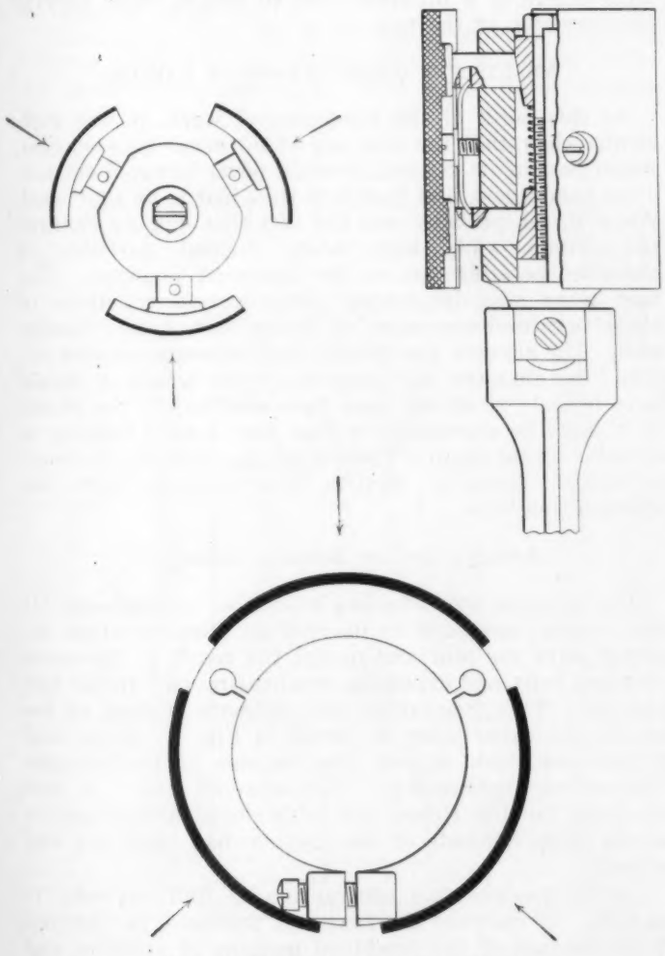


Fig. 4—Types of Lead Lap Used

The Circumference of the Lead Lap Shown in the Upper Portion of the Illustration Was Increased by Using an Adjusting Screw so as To Create Three Centers of Normal Pressure, Represented by the Arrows. In the Lower Portion, the Lead Lap Shown Was Designed To Have Three Shoes with Pins Attached, All Equal as Regards Height, Expanded Simultaneously by Two Cones Which Were Drawn Together by a Screw

It is an error to assume that generation of a helix will result in a cylinder. It is a basic fallacy inasmuch as a helix must have pitch and no material can be employed commercially which will have sufficient durability to maintain a true cutting face wider than the helix pitch. Analysis also pointed an accusing finger at the principle of generating from points not integral with the work, although this principle is not basically wrong and has a marked degree of success in the generation of gear-teeth. But, for reasons peculiar to the treatment of cylinders, this method of generation from externally fixed points, such as the "bench marks" in the surveyor's terminology, has no rightful place in cylinder grinding and suggested the question, Why would it not be possible to generate a finished cylinder from the machined cylinder-bore itself?

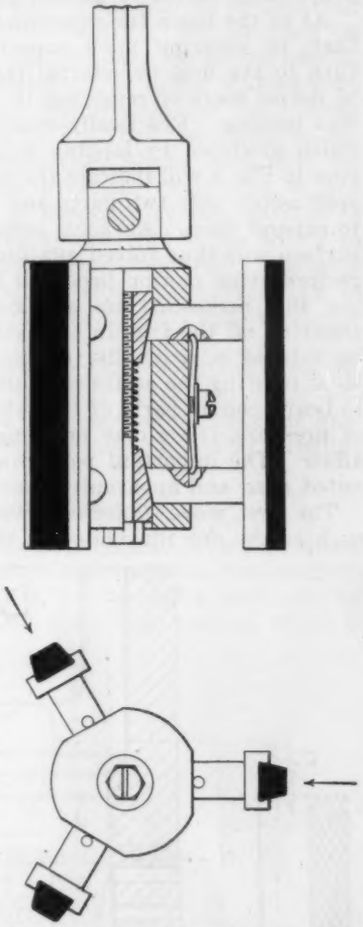


Fig. 5—Application of Bonded Abrasive

An Abrasive Stone and Pins Were Die-Cast and Mounted in the Same Manner as Described for Fig. 4

Reverting to that group of imperfections caused by improper applications of abrasive, we are confronted with stone wear. The elastic properties of cast iron and steel in cylinder-walls demands a free-cutting stone, with clean shearing-properties. An abrasive stone sufficiently hard to maintain its initial dimensions throughout one relatively large operation, if caused to pass over the work continuously in the same direction and phase, will load up or glaze the face of the stone. This is strictly analagous to the shearing action of a file. It will shear when clean. Shearing of soft materials causes it to load when moved in one direction. Motion across the face of the tool in a different direction is required to dislodge the waste material and clean the file. The same condition obtains in the application of an abrasive. Rapid rotation of an abrasive wheel of varying density caused periodic bombardment of the cylinder-wall, due to vibration caused by unbalanced centrifugal forces. The process was very slow because the area of abrasive in contact with the work was, relatively speaking, extremely small.

Summary of Causes of Imperfections

Summarizing the shortcomings of the conventional cylinder-grinding method of that period, we had, first, improper method of cylinder generation and, second, improper application of bonded abrasive.

As to the basis for experimentation, it is only natural that, in entering upon experimental work, one would turn to the first objectional feature, fuzz, and endeavor to devise ways of removing it. The only known method was lapping. Practically everyone is familiar with the finish produced by lapping with a split piston. Reference to Fig. 3 will indicate the essentials. The piston was split nearly into two parts and various means were used to expand them. Abrasive compound placed on its outer surface was thus forced against the cylinder-walls. The reciprocating motion produced by the operator in pumping this makeshift up and down was responsible for shearing off the fuzz in the cylinder. The piston had to be rotated occasionally, or indexed to a new position, so as to bring the active portions, indicated by the arrow, to bear upon all parts of the cylinder. It had two centers of pressure, if we may presume to analyze such a crude affair. The important point was that the process *eliminated fuzz*, and apparently opened the avenue to success.

The first move, therefore, was to design a better lap, such as the one illustrated in the upper portion of Fig. 4. Here we had an adjusting screw increasing the circumference of the lap, thus creating three centers of normal pressure as represented by the arrows. Lead shoes were employed, first because they would not scratch the cylinder barrel, but principally because, due to their softness, they would also retain abrasive compound. The particles of abrasive would imbed themselves in the lead shoe. This attempt was crowned with but a small amount of success. The finish secured was desirable and the accuracy was commendable, but the method was extremely slow in operation. Evidently, sufficient normal pressure could be used only in a cylinder of the size for which the lap was made.

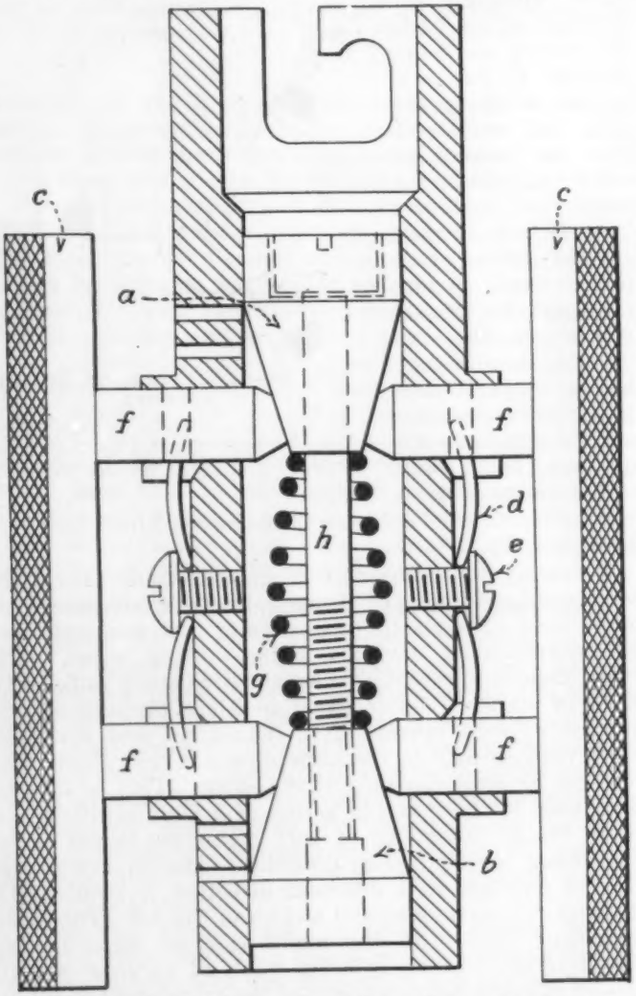


Fig. 6—Cross-Section of a Twin-Three Grinder

The Upper and the Lower Cones Are Shown at *a* and at *b*. The Steel Stone-Holder Is Shown at *c*. The Other Important Parts Are the Stone-Retaining Spring *d*, and Its Retaining Screw *e*; the Pins, *f*; the Cone-Adjusting Spring, *g*; and Its Adjusting Screw, *h*

To increase speed and to allow a greater range of application, a second lead-lap was designed, such as is shown in the lower portion of Fig. 4. In this lap three shoes with pins attached, all equal as regards height over-all, were expanded simultaneously by two cones which were drawn together by a screw. Great normal pressure was obtained with this construction, which resulted in faster removal of stock. It was still a slow operation, increased pressure notwithstanding. Much improvement had been made, however, in the matter of adaptability. The set-up as shown was capable of ¼-in. expansion. The chief advantage was that the shoes could be replaced with others of a different over-all height, thus varying the diameter of the tool.

Analysis of Disadvantages of Lapping

At this point of the experimental work, it was sufficiently clear that the lead lap would never be a success. Regardless of its virtues, it would never be rapid enough. Time meant cost, and therefore time had to be shortened. Worst of all, perhaps, was the fact that lapping charged the cylinder-walls with finely divided particles of abrasive, possibly due to the increased pressure. The fact alone was important. Improper distribution of abrasive caused more wear of the lap than of the cylinder-wall. The keynote was struck when someone pointed out that "the abrasive was everywhere but where it should have been." It should have been confined to the shoes. If it could be segregated in that way, a solid coating of abrasive would result. Therein lay the solution; *confined*, or bonded, abrasive. Stating it in a single word, the solution was *stone*.

Application of Bonded Abrasive

The problem was attacked with new enthusiasm. It was simply necessary to die-cast an abrasive stone together with the pins and mount the result in the same identical body and expansion mechanism used in the last lead-lap. This innovation, the ultimate reward of research and experiment, is shown in Fig. 5. It cut and it removed stock rapidly, the feature of performance theretofore unobtainable. This lowered cost. It was accurate, for the times, and it produced a satisfactory finish. The elements of the problem had been met and solved.

Let us analyze this contraption to find out why it worked. It removed the fuzz and produced the desired finish because of the combined motions of rotation and reciprocation. The stone thus employed sheared off the high spots just as in the lapping process. The stone was maintained clean due to the two motions, just as the file is cleaned by a second motion at an angle to the one which loads it. Although the same means of expansion was employed, the normal pressure per unit of abrasive area had been increased enormously, due to the decrease

in the total area of the abrasive face in contact with the walls of the cylinder. This forced the individual particles of the abrasive deeper into the metal. They could not lodge there, however, as the abrasive was bonded firmly together. The abrasive which did wear off was slight in quantity and this was promptly flushed out of the cylinder by a copious flow of kerosene. The flow of kerosene served three purposes; (*a*) it acted as a flushing agent for the cylinder, (*b*) as a cleansing agent for the stone, and (*c*) as a coolant for the work. Purpose (*c*) is of no small importance, because rapid removal of stock is always attended by heat. This heat had to be dissipated to prevent warpage and expansion, either of which would result in error when determining cylinder diameters.

The amount of stock to be removed by each stone was less than in the wheel method, as the tool was self-centering. The three-point contact of the tool caused the axes of tool and cylinder to coincide. This was a mechanical operation devoid of personal element and independent of imperfections of fixtures and machines. This makes the necessity of a flexible drive self-explanatory. Another reason for the rapid stock-removal was the greatly increased area of abrasive in contact with the cylinder-walls. It is an extremely conservative estimate that in this new process there was more than ten times the area of contact.

The cone assembly shown in Fig. 6 was the means of exerting normal force. It was also the means of securing considerable expansion. The main object of this design, however, was compensation for unequal diameters and uneven stone-wear. When entering a portion of cylinder smaller than the average, the stones were forced in at the end. This caused the entire cone assembly to shift. It should be noted that the diameter at the middle of the tool remained constant. Thus the job of shearing off this portion of the cylinder-wall fell, not so much on the ends of the stone but rather along its entire length, particularly the central section. Due to the floating-cone feature, it was possible to compensate for the uneven stone-wear as shown in Fig. 7. That the cones be opposed is essential; for, were they placed each with its apex pointed in the same direction, as in Fig. 8, the stones and holders must of necessity remain parallel to the axis of the tool, thus being deprived of the ability to conform themselves to conditions encountered. The price of this procedure is localized stone-wear, resulting in tapered stones, snaking motion of the tool and inaccurate cylinders.

Summarizing this discussion of the principles involved, we find that it is capable of being correlated under two brief captions; namely, a new method of cylinder generation and a new departure in the method of handling bonded abrasive.

Corrective Measures

With the basic principles established, it became necessary to redesign the grinder in preparation for commercializing, as indicated in Fig. 9. Provision was made for power drive, as it required more than manual effort to

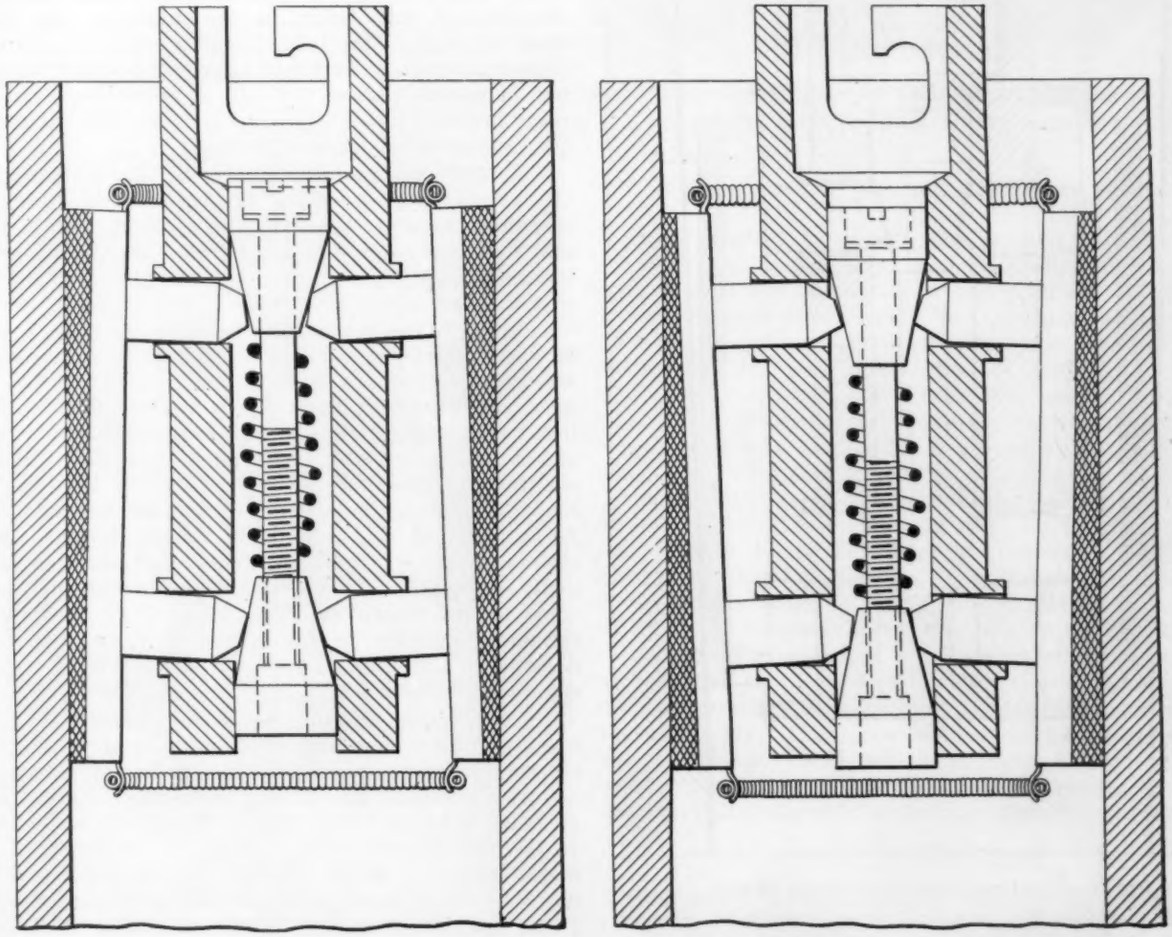


Fig. 7—Means of Allowing for Stone Wear

Use Was Made of the Floating-Cone Feature in Compensating for Wear. It Is Essential that the Cones Be Opposed

remove stock rapidly up to the capacity of the grinder. Greater precision in manufacture accomplished the rest and the grinder was released to the industry, being introduced first in the service or reconditioning field.

Placing any tool supposed to be fool-proof in the hands of the trade is a severe test, and trouble developed immediately. The greatest trouble was stone failure, due to breakage and loosening of the pins. Evidently the method of mounting the stone had to be improved. The grinder enjoyed popularity despite its crude design, as it filled the requirements of speed, accuracy, good cylinder-finish and low cost. Crude as it was, tolerances of 0.001 in. were commonly maintained. The only corrective measure of any importance was the redesign of the stone holder. The pins were riveted to steel stampings and the stone was die-cast into the stamping, the entire assembly being far more rugged than the older form

Problems Encountered in Production

The application of the grinder to manufacturing duties marked the beginning of the period of true development of the new method. Entirely new conditions were met, which demanded different treatment. Manufacturers, like other business men, can be divided into two classes; namely, the progressives and the conservatives. The progressive element, seeing the strides made

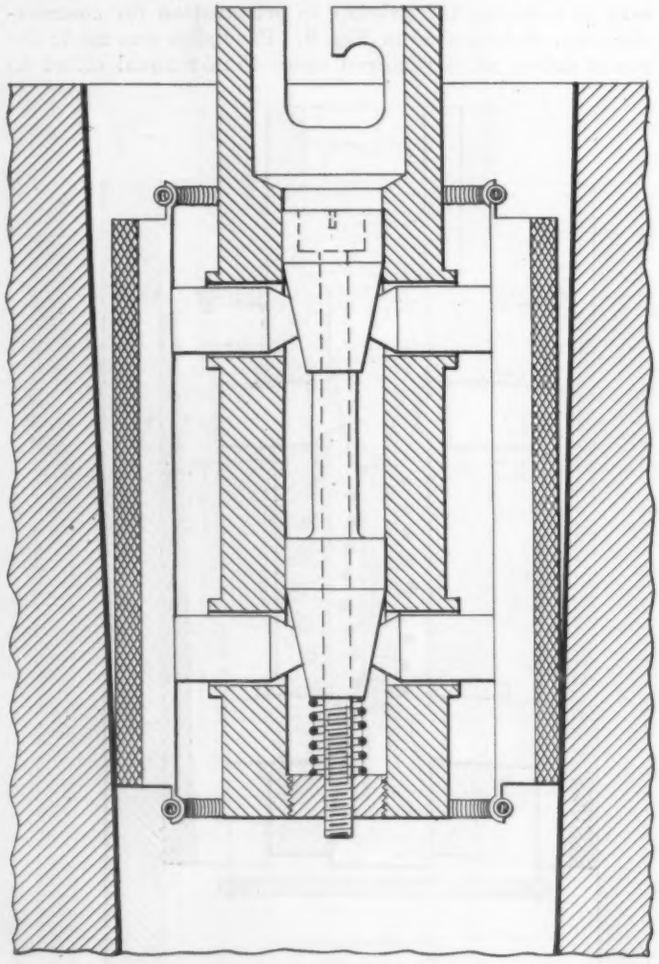


Fig. 8—Compensating for Stone Wear

If Each of the Cones Has Its Apex Pointed in the Same Direction, As Shown, Instead of Having Each Apex Opposed to the Other, the Stones and Holders Will Remain Parallel to the Axis of the Tool and Cannot Conform to the Conditions They Encounter

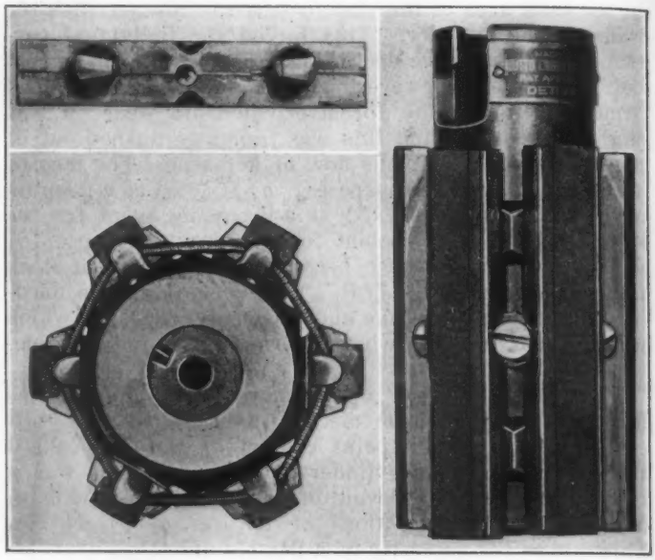


Fig. 9—Redesigned Grinder for Commercial Use

Provision Was Made for Power Drive, for the Purpose of Removing Stock Rapidly. Due to Breakage and Loosening of the Pins, Stone Failure Developed and This Necessitated an Improvement in the Mounting of the Stones

by the new method in the service field, offered cooperation in the development of the method for manufacturing duty. The progressive element helped materially in this development but, being in the minority, the progress made as regards the industry as a whole was slow. The conservative class withheld approval because the principle appeared radical. These conservatives had large sums invested in costly equipment and, last but not least, they conceived of labor difficulties.

The first installation disclosed two obstacles; first, the grinder was unsuited to the job and, second, the machines were unsuited to the method. Both grinder and machine permitted too great a degree of personal influence and they were accordingly changed. The grinder had to be redesigned to incorporate means of expansion while in operation. It also became necessary to design grinders capable of maintaining tolerances in blind-end cylinders, those having connecting-rod clearances and port openings. These needs were filled by the brake-type adjustable-set and positive-stop drive-heads shown in Fig. 10, which controlled expansion, and by the six-stone grinders of the type shown in Fig. 11, which bridged large irregularities in cylinder barrels. It was further found that pins and holders lacked rigidity; consequently, new grinders had these parts more ruggedly designed. This brought us to the slotted-body construction shown in Figs. 12 and 13 in which the tangential thrust on the abrasive stone was applied directly to the stone holder and not to the pins, as are the spokes of a wheel.

An unforeseen difficulty developed at this stage. When machines were supplied with mechanical means of reciprocation and power was available in abundance, stone failure developed due to heterogeneous bonding of the abrasive stick and non-uniformity of successive stones. It became necessary to investigate processes of stone manufacture to secure uniform and homogeneous bonding. This was finally accomplished by a new process and a new mechanical device. Kerosene had to be cooled and filtered. Reservoirs, sumps, filters and even radiators were brought into play to meet this end.

Recognition of the cooperation of the progressive group of manufacturers is only just. Without cooperation, this method of grinding would never have had the entree to production practice. The more conservative manufacturers now realized the advantages of this radical process, for it manifested itself in the form of a better product at lower cost. Competition, always keen in the automotive industry, drove it home by reduction in prices of the better product. Today, acceptance is widespread. In the automotive industry alone we find more than 85 per cent of the American car-builders using the new process and the European manufacturers are a close second.

Recent Developments

Requirements for still greater accuracy caused further research. The stone holders were next expanded and subjected to normal pressure by pins detached from the holders. This gave non-rigid construction of the stone assembly, and the grinder consequently was termed a non-rigid grinder. It had further attributes in its adaptability. This stone holder became interchangeable, fitting grinders of various diameters, which simplified the duties of purchasing agents and the methods used in stock-rooms as well as in the shop. Further, it expedited the manufacture of stone assemblies. The holders were made from solid-bar stock, hardened and ground to precision limits. They were refillable at small cost, and the items of cost and waste were reduced still further.

[3] Chief engineer Hutto Engineering Co., Inc., Detroit, who, in the absence of Mr. Hutto, read the paper and replied to questions raised by the various discussers.

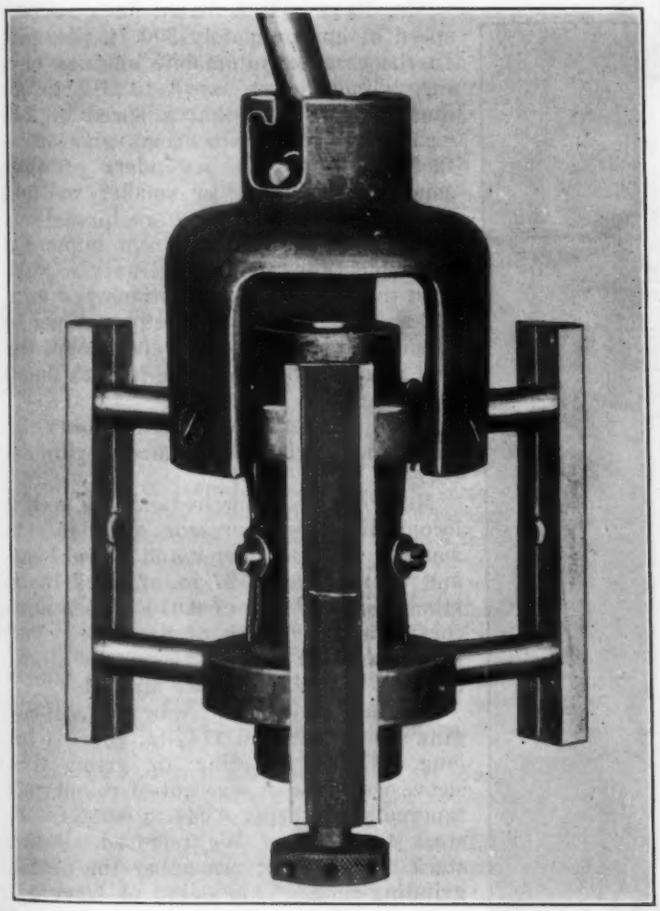


Fig. 10—Type of Adjustable Drive-Head to Control Expansion

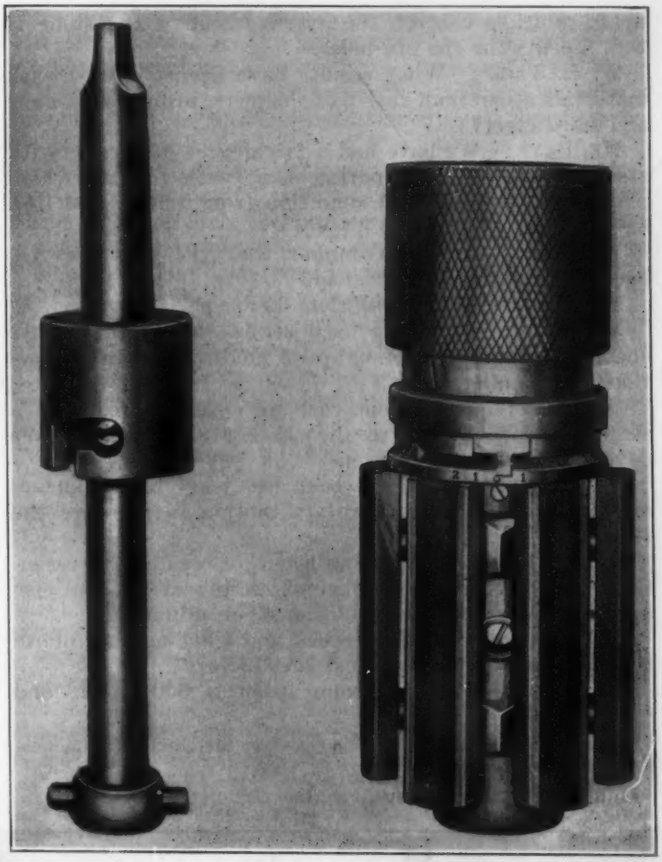


Fig. 11—Type of Six-Stone Grinder Which Bridges Large Irregularities in Cylinder Barrels

These grinders have been but recently introduced to the industry and reports are decidedly encouraging. Present accuracy obtainable in the grinding of cylinder barrels is less than 0.0005 in. Greater accuracy in cylinders of internal-combustion engines does not seem warranted. In bearing surfaces not subjected to great heat and bombardment of explosions, smaller tolerances may justly be demanded. In one particular grinding operation now in production, a tolerance of 0.0001 in. is maintained with this method of grinding.

Undoubtedly, room for improvement along these lines exists. Greater precision will soon be required in the manufacture of parts other than cylinder barrels of internal-combustion engines. The never-ceasing demand of the public for better cars is always met by the earnest effort of the automobile builders to give the public what it wants. The engineer will specify closer tolerances, and the part will need to be ground closer. The grinder manufacturers must help the car manufacturers to still the public cry. Parts now held to 0.0001 in. must soon be held closer. With all these signs impending, it is comforting to know that the research laboratory of today is working steadily to meet the demands of tomorrow.

THE DISCUSSION

Question:—In this method, what is the average cost of the stone itself, not including labor?

G. C. Paye[3]:—The cost depends upon the amount of material that is to be removed. With six grinders set

up in multiple control, the average cost of the stone is 2 to 3 cents for the six holes.

W. E. TABB[3]:—What results have been obtained with materials other than cast iron; namely, bronze, soft steel and hard steel?

MR. PAYE:—We have had a fair degree of success with steel. We are still experimenting with bronze, which presents a very different condition from that of cast iron or of steel.

MR. TABB:—Is there danger that the abrasive will become imbedded in soft steel?

MR. PAYE:—Yes, if sufficient kerosene is not used.

MR. TABB:—Have you used soluble oil on the crankshaft as a lubricant for external honing, and in connection with honing bores?

MR. PAYE:—Yes, in one case we experimented with a steel cylinder but the result was not satisfactory. We advocate the use of kerosene.

F. J. BEDFORD[4]:—Has it been necessary to use an up-and-down motion with a rotary motion to preserve the stone?

MR. PAYE:—To produce an accurate result, it is essential to use the proper number of reciprocations and also the proper number of revolutions per minute.

R. H. CANNON[5]:—What speed and what number of reciprocations do you find most satisfactory?

MR. PAYE:—The maximum speed is 300 r.p.m., and the number of reciprocations varies from 70 to 100, depending upon the nature of the work and the diameter and length of the cylinder-bore.

[3] Assistant superintendent, F. B. Stearns Co., Cleveland.
[4] M.S.A.E.—Manager of the lubricating department, Magnolia Petroleum Co., Dallas, Tex.
[5] Salesman, Norton Co., Cleveland.
[6] A.S.A.E.—District manager, Norton Co., Detroit.

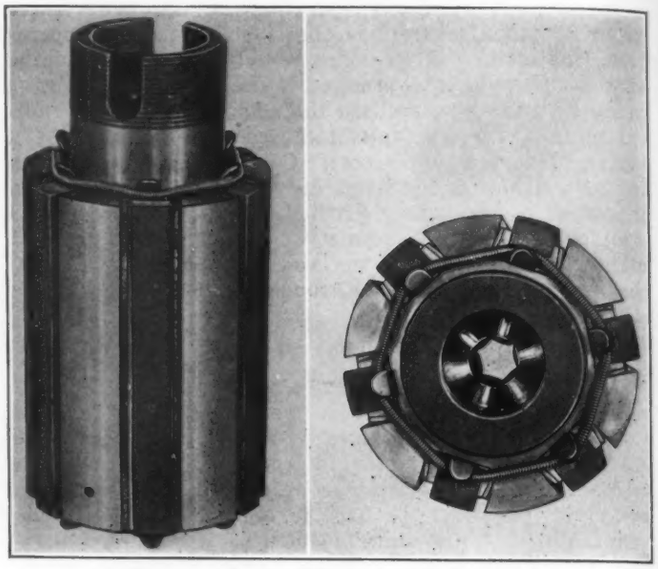


FIG. 13—METHOD OF APPLYING THRUST

In the Slotted Stone-Holder Shown, the Tangential Thrust on the Abrasive Stone Is Applied Directly to the Stone Holder and Not to the Pins

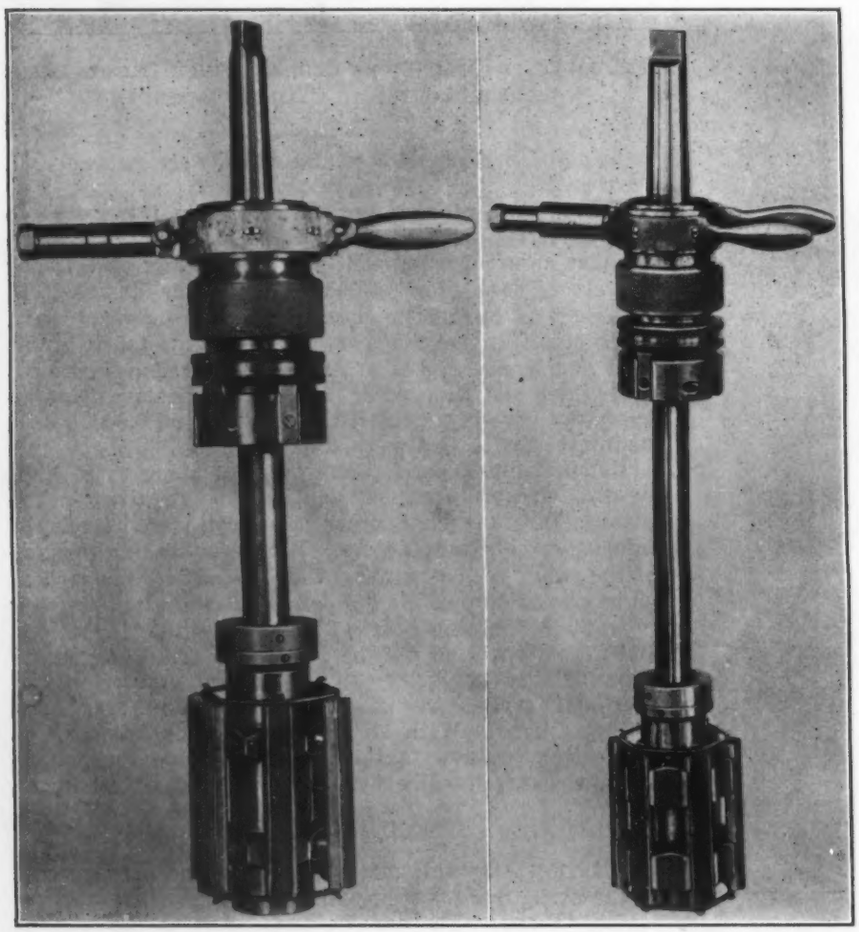


FIG. 12—GRINDER HAVING A SLOTTED STONE-HOLDER

QUESTION:—What is the basis for determining speed?

MR. PAYE:—It is based on a surface speed of approximately 200 ft. per min. In the case of automobile engines having cylinder-bores say 3 to 3¼ in. in diameter, we find that a speed of 240 r.p.m. and 70 reciprocations give satisfactory results. In cylinders of very small bore, 1½ in., or smaller we find that 200 r.p.m. and 100 reciprocations give the best results. From numerous experiments we find it necessary to vary both the number of revolutions per minute and the number of reciprocations to produce an accurate bore; also, to get the best results from the stone in both finish and wear.

C. W. JINNETTE[6]:—What has been the experience with large-size cylinder-bores?

MR. PAYE:—In one instance we used a locomotive air-compressor cylinder. It was 8¼ in. in diameter and 11 in. long, and we removed 0.187 in. of stock in 18 min., or at the rate of 0.010 in. per min. for the entire length of the bore. The bore was kept within the same alignment as it was before we started.

Another achievement was a Diesel-engine sleeve having a 17¼-in. bore 64 in. long. Before starting to grind this sleeve we found it was out-of-round and tapered, there being 0.034 to 0.035 in. of stock to remove. We removed all the stock but I do not remember the actual grinding-time. This sleeve of large diameter and long length when finished was held to 0.001 in. for its entire length and the finish was ideal in every respect.

Recently we ground a few pieces of tubing of 3-in. inside diameter, and from 6 to 7 ft. long. This tubing contained about 0.95 per cent nickel, which produced a high polish, but it was possible to maintain accuracy within 0.001 in. for the entire length.

MR. CANNON:—What is the relation between the surface speed per minute and the rate of removal of the stock; also, between surface speed and the finish obtained?

MR. PAYE:—A coarse stone is used to remove stock, but the desired finish is not obtainable with a coarse stone. An allowance of 0.0010 to 0.0015 in. is general in automotive practice for finish grinding. We remove this amount of material on four and on six-cylinder engine-blocks by grinding.

RATIO OF ROTATION TO RECIPROCATION

MR. CANNON:—Do you find for instance that by rotating the head faster you get a better finish?

MR. PAYE:—Maintaining the surface speed at approximately 200 ft. per min., allowing a variation of only a small percentage either way, gives the best results. This is due to the fact that the speed can be increased if it is possible to increase the number of reciprocations at the same ratio, but a ratio of approximately 3½ to 1 is necessary. On small bores, a ratio of 2 to 1 has given good results.

If the reciprocations were maintained at the same speed it might be possible to get results under some conditions. At present only a few machine-tool builders produce a machine that will both rotate and reciprocate at the speeds which we consider necessary for our type of grinder.

LOGAN A. BECKER[7]:—Do you strive to obtain a high finish on the cylinder-walls, or is there a possibility that the finish will be too fine?

MR. PAYE:—We do not try to obtain a high degree of polish. There is a possibility of a finish being too fine or having too high a degree of polish. This condition will necessitate a longer run-in of the engine before the rings become properly seated.

H. C. ABELL[8]:—Do you recommend using a hone in a cylinder that is to be reconditioned, without first regrinding the cylinder?

MR. PAYE:—In practically all cases where reconditioning is necessary and the bore shows the average out-of-round or tapered condition, we start with the grinder and finish the bore using the same stones in most cases. Where there is a deep score we generally advocate boring or reaming first to prevent excessive stone-wear.

F. W. STEIN[9]:—What is the effect on the hone when in use in a two-cycle-engine cylinder?

MR. PAYE:—That depends on the size of the ports. In one case, on a large sleeve, we inserted pieces so that the grinder stones could ride over the ports without dropping in. When the ports are not long, the stones will bridge over them.

COARSE STONES AND KEROSENE PREVENT OVERHEATING

MR. TABB:—What difficulties do you experience on account of heat generated by friction?

MR. PAYE:—The cylinder is kept cool by using a coarse stone and plenty of clean kerosene.

MR. TABB:—In such a case is it possible to maintain the desired finish?

MR. PAYE:—It produces accuracy but not a smooth enough finish. The cylinder is allowed to cool, so as to get accurate dimensions, and then a finishing stone can be used.

MR. BEDFORD:—What is the difference between honing and broaching?

MR. PAYE:—Honing and grinding remove the metal but broaching displaces metal.

A. M. JOHNSON[10]:—In this method, what is the depth of the scratches?

MR. PAYE:—The depth is very slight. We have inserted a piston into a cylinder that showed scratches and moved the piston up and down, whereupon about 50 per cent of the scratch marks disappeared. We have not been able to measure the depth of the scratch marks but they are less than 0.0001 in., although they appear to be deeper.

[7] Chief engineer, A. P. Schraner & Co., Cleveland.

[8] A.S.A.E.—Plant engineer, Laminated Shim Co., Inc., Long Island City, N. Y.

[9] A.S.A.E.—Superintendent of the small engine division, Fairbanks, Morse & Co., Beloit, Wis.

[10] A.S.A.E.—Special representative, Hutto Engineering Co., Inc., Highland Park, Ill.

The New Foreign Competition

AMERICAN manufacturers who are building up export business must realize that the new foreign competition, particularly from the French, is as much a matter of modern productive economies as it is of those other factors which have so long been associated with European production. As Isaac F. Marcosson points out in an article in the *Saturday Evening Post*, factories like the Citroën and Schneider works understand the principles of mass production as thoroughly as do American manufacturers. The Americans were, perhaps, the schoolmasters in teaching mass-production economies, but today the pupils are on an equal basis with the teachers.

American exporters must realize that Europe is coming back, and coming back swiftly. The remarkable financial recovery of France in a little less than a year is only one indication of what can happen when the Europeans finally throw aside politics and face their problems with a sane viewpoint.

In the battle for export markets the American manufacturer for several years has had advantages of superior machinery which he could use on a large scale. Today that advantage is being wiped out. The American has also fancied that his superior knowledge of marketing and merchandising methods was helping him. Today the European manufacturer is just as keen a merchandiser as the American.

If America is to hold its place in world trade it must realize that many of its advantages during the last few years either have been wiped out or balanced to a large extent. The next phase of the battle is one of new ideas, one of keeping a step ahead of European competition. Tariff walls and favored-nation agreements are only one phase of the new battle. There are other and equally important phases which the American manufacturer must understand thoroughly before he can feel as secure as he has felt since 1918.—*Printers Ink.*

Tractor-Trailer Express-Transfer Operation

By M. T. Hanrahan[1]

Transportation Meeting Paper

For transporting solid loads of express between the various railroad terminals in Chicago, the loading time required was too long for economical operation with motor-trucks.

By eliminating the waiting time of both powerplant and chauffeur, a fleet of tractors and semi-trailers has proved to be prompt, economical and satisfying for this work.

Incidental economies have been possible in loading, in reduction of checking operations, and in terminal platform requirements.

A simple control system enables the dispatcher to direct the movement of trailers to meet the needs of the various terminals without providing excess capacity and without unnecessary haulage of empty trailers.

CHICAGO is the greatest railroad center in the world, the terminus of 23 trunk lines. The local operations of the American Railway Express cover approximately 500 trains and 1000 cars daily. We transfer about 1800 loads of passing express between 18 terminals in 24 hr.

Since the flow of express traffic from all parts of the Country converges here, the economical and prompt handling of express matter between our terminals is of prime importance. In our business, service is the only commodity we have to sell, and we consider that, when a person patronizes our company, he does so because of the urgency of getting his shipment to its destination in the least possible time. Our responsibility to our patrons makes us keenly alive to the necessity of getting the best available machinery for performing our task.

The history of the express business shows a steady development of handling methods. When horse-drawn equipment was our only reliance, we purchased the best horses and wagons available to furnish express service. The service we rendered was then considered fast. When the motor-truck was introduced, the world began to accelerate and the old methods suffered in comparison with the new. The time consumed in performing certain tasks was reduced considerably by the use of motor-trucks. Earlier train-connections could be made and there was a general speeding up of our entire service.

While the motor-truck was a step forward in speed, it did not fully meet our requirements as to economical handling of express matter such as solid loads for transfer, because the power unit was idle during the period of loading and unloading. This caused us to investigate the practicability of tractors and trailers. There were many types on the market and it was necessary that we secure a tractor-trailer unit having the operating flexibility of a motor-truck and other advantages, particularly more economical operation.

Semi-Trailers Selected

After considerable study we fixed upon the semi-trailer type as best suited to our needs, and in 1921 we started with 5 tractors and 15 semi-trailers for use in handling crosstown or terminal-to-terminal transfer matter. In handling our large volume of express we found that the semi-trailer proved the ideal vehicle-unit, principally because, during the interval of loading and unloading, the power unit was engaged in productive work. Where terminal platform-facilities were inadequate, the trailer provided the necessary relief by eliminating congestion, the faster operation of the trailers making it possible in many cases to load the trailers directly from the express cars. The man-to-man tally of freight between terminals, that is necessary with motor-trucks and wagons, is eliminated by sealing trailer loads, thus speeding up the handling.

The generally satisfactory showing of this initial fleet of tractors and trailers indicated that the plan was sound and that additions to the fleet could safely be made. The growth of our fleet at Chicago is illustrated in the following figures, which include the latest addition to this fleet:

Year	Tractors	Trailers
1922	24	63
1923	31	78
1924	31	100
1925	45	105

How the Units are Operated

The tractor-trailer is operated as a unit by the chauffeur, whose only duties are to haul and "spot" trailers. The loading and unloading are performed by terminal forces, except that vehicle crews have charge of unloading of deliveries to large individual receivers of express. This arrangement is in the interest of economy. When a trailer is loaded and ready to move, the coupling of the tractor and trailer is effected automatically, without the necessity of the chauffeur leaving the tractor cab. The tractor backs up to the trailer and lifts the front end of it by engaging the guide wheels on the trailer with the mounting tracks of the tractor. This operation also locks the trailer to the fifth-wheel coupling-device on the tractor, automatically releases the trailer brake, and elevates the front supporting-wheels of the trailer. A lever in the chauffeur's cab reverses the process when the trailer is to be left. The trailers are equipped with internal-expanding brakes, which control them on grades or in making a stop on the level.

When the tractor-trailer service first was installed, the operation of the initial 5 tractors and 15 trailers was not very difficult, but when a large number of additional units

[1] Superintendent, vehicle department, American Railway Express Co., Chicago.

was added to the service their operation and control became a problem. It was apparent to us that if we were to keep the tractors and trailers under control it would be necessary to improve our methods of operation. We developed a system of control, by means of a chart or despatcher's board, whereby the location of each unit is known at all times to the despatcher in charge of the tractor-trailer operations. From reports which come to him from the terminal despatchers, he knows which trailers are en route to terminals and which are standing loaded, empty or about to be loaded. This tractor board carries the names of all of our terminals and other points where trailer service is used during some part of the day.

For each trailer there is a peg marked with the number of the trailer. As the movements of the trailer are reported to the tractor dispatcher, he moves the peg to show whether the trailers are en route loaded or empty, or standing at a terminal, loading, unloading or empty. By referring to this chart he can see at a glance the number of trailers standing loaded at each terminal, and when one terminal calls for empty trailers, he refers to the chart and arranges to get to that particular terminal, in the shortest time possible, all the trailers standing elsewhere with loads for that terminal. This method prevents wasted travel and the possibility of dispatching to any terminal more service than is required. A driving schedule is maintained rigidly, and any variations therefrom must be explained fully by the chauffeurs involved.

One Trip in Three Made Without Load

For the efficient operation of this equipment it is vitally necessary that the proper ratio between the loaded moves and the empty and light moves be not exceeded. Our experience shows that approximately 65 per cent of the total moves are made with loads, but not always with capacity loads. Delayed trains and other operating conditions cause fluctuation in the amount of traffic to be handled between terminals. At certain hours of the day or night all trailers are moving with capacity loads, while at other times the traffic is less. Our average loaded moves per tractor per 8 hr. during the last 4 years has been 13¼.

Our tractor fleet is operated in three 8-hr. shifts daily. One change of shift is made on the street, the others in the garage so that the tractors can be given fuel and oil and the necessary mechanical attention.

This service has enabled us to dispense with a considerable amount of horse-drawn equipment, and this in turn made possible a reduction in stable space. There was comparatively little increase in garage requirements because the trailers are never in the garage except for repairs, and only about one-third of the tractors are ever in the garage at one time.

The advantages of this type of equipment may be summed up as follows:

(1) One tractor serves for three hauling units, each of which has double the capacity of the ordinary express vehicle
(2) Uninterrupted loading, due to waiting semi-trailers
(3) Saving of valuable terminal-platform space, because of the ever-present loading-space provided by the semi-trailers
(4) Decrease in garage space
(5) Elimination of waiting time of the chauffeur during preparation of load
(6) Constant productivity of the units representing the principal part of the investment, as the tractors are not idle during loading and unloading

In spite of these advantages, tractor-and-trailer equipment is not readily adaptable to all cartage problems. Each situation should have careful study before such service is installed.

Machinery and Labor

IF it is agreed that productivity is the basis of wages and the general welfare, there should be ready cooperation in all policies which clearly tend to increase it, and this should make an end of opposition to labor-saving methods and machinery. It is not unnatural that wage-earners should view with antagonism the installation of machinery which seems to displace labor, but the wisest labor leaders know that in the aggregate the effects of machinery are not to reduce employment but to increase and cheapen production.

So long as the people have wants unsatisfied there will be room for more machinery, for wherever it releases labor from present uses it will release new purchasing power sufficient to employ it. There may be a shift of labor, as from carriages to automobiles, but no less employment.

Since the effect of machinery is not to reduce employment but to increase real wages, the idea that working hours should be reduced to offset the effects of machinery is an obvious fallacy. Instead of offsetting a loss, that policy would offset a gain. Instead of preventing the workingman's degradation, it would prevent his advancement. If it could be carried out it would put an end to industrial improvement and the rise of the standard of living. The answer to the workingman's fear of machinery is to be found in a comparison between the labor conditions in China and those in the United States.

There is a fair balance to be struck between rest, recreation and leisure on the one hand, and labor, production and possessions on the other, but it must be borne in mind that it is impossible to divide any more than is produced, and that a rising standard of living is possible only with constantly increasing production.—From an address by George E. Roberts, vice-president, National City Bank.

The Spirit of Research

RESEARCH conveys at least two ideas: experimental studies in unexplored fields of science, and correlation of discoveries in partially explored fields and the systematizing and codifying of the correlated work.

The indirect results of the spirit of research are less obvious but perhaps equally important. This spirit of research, an intellectual curiosity to find out the truth, has become a large factor in our specification work as well as in our distinctively research work.—H. F. Moore, president of the American Society for Testing Materials.

Coordinated Rail and Motor-Truck Transportation

By GEORGE W. DIXON[1]

TRANSPORTATION MEETING PAPER

MUCH has been written upon the subject of coordinated rail and motor-truck transportation and it is not to be doubted that more will be written within the next few years. Effective and economical combination of the leading means of transportation of our time is a momentous subject worthy of the consideration of our ablest minds. This thought applies to both the passenger motor-vehicle and the motor-truck or freight vehicle. Since my experience has been confined almost entirely to the latter, I shall limit my remarks to a discussion of the applicability of the motor-truck as a mover of freight, particularly to that already large and constantly increasing type, package freight, better known as less-than-carload freight. Likewise, since our company has long specialized in the intra-city movement of freight for railroads, it is perhaps advisable for me to consider only that phase of the situation.

Five principal uses for the motor-truck in the movement of less-than-carload freight, and two secondary uses, are cited by the author, who believes that the attitude of railroad executives has changed from one that considered the motor-truck a menace to one that considers its use desirable if it enables the railroad to serve the shipping public better.

Analysis is made of each of the motor-truck usages mentioned. In conclusion, it is stated that the motor-truck and semi-trailers bid fair to become economical auxiliaries to all-rail transportation. It seems logical that the railroads should make every possible investigation of this new branch of service, that they study the needs of their shippers, and that they analyze that portion of their business which escapes them, to determine if the same service cannot be rendered by themselves.

There have been numerous indications in the past that some railroad executives have looked upon the motor-truck as a menace. We believe that this attitude has changed. It is apparent today that railroad executives are in a receptive mood, and that they are keen to consider the use of such vehicles if by so doing they can serve the shipping public better. It is true, too, that the railroads have been compelled to combat motor-truck competition fostered by a lack of regulation and supervision by the governing bodies which had jurisdiction over the rail units. It is to be hoped that in the near future questions of Government supervision will be settled to permit the use of such vehicles on a more equitable basis from the railroad point of view. It is certain that, when this condition obtains, the motor-truck will prove a more profitable auxiliary to rail movement of freight.

PRINCIPAL MOTOR-TRUCK USES

There are at least five principal uses for the motor-truck in the movement of less-than-carload freight which seem entirely feasible, and two others which we understand are now being considered seriously. They are as follows:

(1) Station-to-station hauling within well-defined distance-limits, instead of peddler trains
(2) Hauling from small to larger stations to effect the concentration of freight in through cars
(3) Hauling from a central delivery-point to smaller stations for final delivery to the consignee
(4) Interchange between railroads and boat lines, and cartage to replace lighterage
(5) Hauling to and from a transfer platform to the various designated delivery-points

Two further uses for the motor-truck are now receiving considerable attention among certain railroads. So far as can be determined, few attempts have been made to employ motor-trucks for such purposes. Time and actual tests will alone determine the efficiency of motor-trucks on such movements, which are (*a*) hauling direct from industries to transfer platforms to eliminate switching delays encountered in the movement of industrial trap-cars and (*b*) hauling of standardized containers for certain classes of merchandise to permit unit shipments to designated points. A short analysis of each of the foregoing uses is presented herewith.

ANALYSIS OF USAGE

Several of our Eastern railroads already are making effective use of the motor-truck in station-to-station hauls. Much controversy has developed as to the economy of such service. It is not our intention to discuss this, but the fact remains that the railroads which have instituted such service have in each instance kept the trucks in service and, in most cases, have increased materially the number and extent of the hauls. This is clearly indicative that they, at least, find it profitable.

The number of railroads using motor-trucks for hauling from small to larger stations to effect concentration of freight in through cars, and to haul from a central delivery-point to smaller stations for final delivery to the consignee, is constantly increasing.

Trucks for the interchange of freight between railroads and boat lines, and lighterage replaced by motor cartage, are so well established as to require no further comment here. Any discussion on this point probably would involve the question of the superiority of motor-truck to horse-drawn vehicles.

Here in the West the use of the motor-truck for hauling to and from a transfer platform to various desig-

[1] President, Arthur Dixon Transfer Co., Chicago.

nated delivery-points has but started. In those instances where it has been so applied the service has been found to be both practical and profitable, and there is little indication that the users would revert to their previous method of handling.

Hauling direct from industries to transfer platforms to eliminate switching delays encountered in the movement of industrial trap-cars is rather new and, so far as can be determined at this time, no actual installations of trucks have been made for the purpose by the railroads. It implies the use of the tractor-truck and semi-trailers.

Studies are being made to determine the practicability of placing semi-trailers at the loading platforms of industries in lieu of trap-cars. These would remain available for loading until called for by a tractor. It seems apparent from the studies so far made that this service can be used in many instances with considerable saving of time and money. The North Shore Electric Railway is using this system to advantage locally. The item of time saved is a major one, it being frequently possible to save from 24 to 48 hr. in the dispatch of merchandise.

Hauling by trucks of standardized containers for certain classes of merchandise to permit unit shipments to designated points has been and is constantly being discussed by our trade papers and technical magazines. No mention has been made of the use of motor-trucks in connection with off-rail freight-stations. This subject has been discussed so often that it seems unnecessary to consider the question here.

In my opinion it is doubtful if it ever will be possible on certain freight movements to equal with motor-trucks and semi-trailers the cost of the same movement by box-car and rail; however, this should not condemn the service to be rendered. Frequently the time saved, the amount of rail equipment which can be diverted to the more profitable full-carload business, and the increased business to be secured through better service to shippers, will much more than offset a small added operation-cost. It has been demonstrated that shippers will use those railroads which are prepared to move their merchandise with greater speed. In fact, it is obvious that those roads which do not and will not make every effort to afford shippers along their right of way such facilitated service, sooner or later will find their right of way paralleled by an independent hauler who can and will render the service wanted.

The following conclusions are offered in the hope that they may serve at least as a guide for future constructive efforts.

The motor-truck and semi-trailers bid fair to become economical auxiliaries to all-rail transportation. It seems logical that the railroads should make every possible investigation of this new branch of service, that they study the needs of their shippers, and that they analyze that portion of their business which escapes them to determine if the same service cannot be rendered by themselves.

The attitude of railway executives toward this form of transportation should be a friendly one, and every effort should be made to bring rail and motor transportation into accord, thereby providing the shipper with a better and constantly improving service.

Measuring Temperature

A COROLLARY of the association of heat and temperature with water is the assumption that heat belongs to a body and that temperature measures its intensity. The latter is a pure abstraction, and is thus a state independent of standards of mass, length, or time (or space, time, and matter in the nomenclature of relativity).

Thermodynamics proceeds further and *invents* such convenient fictions as heat-tight enclosures, but the heat engineer *knows* that energy must be continually expended in keeping a boiler or a refrigerator at a temperature different to that of its environment.

The difference between definitive theory and practical reality is that the former was made at a period when it was not known that matter is submerged in a bath of radiation and is full of holes through which this energy can leak in or out. Heat is limited by definition to radiation of such frequencies as will work a thermometric device, but this ignores the existence of other forms of invisible radiant energy, though atomic transformers can build up wireless waves into radiant heat or degrade high-frequency radiation, light, X-rays and the like, into sensible heat.

Flux of Radiant Energy Overlooked

Attention has become focussed in conventional science upon the atom (which is the indicator of heat-exchange) to the oversight of the flux of invisible radiant energy which is an inseparable component of that mobile equilibrium constituting the momentary temperature in space of some selected particle or body. The outermost or valency electrons binding atoms into molecules or other aggregates, such as a space lattice, is the nodal point in those interactions which constitute thermal equilibria, so called because they affect a thermometric device.

Strict accuracy in thermometry requires an impossibility, viz., the absence of heat transmission, because this must create a temperature difference in the same way that a temperature difference causes heat-flow. Any change in relative motion between matter and space involves energy exchanges. If there are two sets of detecting atoms or oscillators in a thermal equilibrium, these exchange energy continually via the intervening space. When there is a difference in rates of vibration between two sets of oscillators, one group receives more energy than it loses, and there is a net gain by one body and a net loss by the other. Then heat is said to have been transferred from one body to another, but, the mechanism of heat transference requires not only the existence of continuous heat-exchanges, but also a continual supply of radiant energy, including convected heat, in order to maintain a heat gradient.

One-Sided Viewpoint Likely to Mislead

The inherent difficulty of all temperature considerations is the liability of a one-sided viewpoint to mislead. An example is misreading of the local mechanism of heat transference by endowing a scatterer of radiant energy with good conductivity, when actually it is opaque to radiant heat.

A gas can be alternately transparent and opaque to radiation, the latter condition obtaining when energy is being absorbed to activate molecules. The scission of activated ions from atomic complexes is intimately concerned with these localized energy exchanges, and in general the individuality of the resonating atom and the characteristic radiation in attunement therewith enters into the mechanism of heat transference, though this may be disguised as the thermal conductivity of the body under consideration.—W. A. Whatmough, in *The Automobile Engineer.*

Problems in Transport-Airplane Design

By CHARLES N. MONTEITH[1]

AERONAUTIC MEETING PAPER *Illustrated with* PHOTOGRAPHS AND CHART

MAJOR problems that have been encountered in the operation under contract of that portion of the Transcontinental Air Mail line between Chicago and San Francisco are outlined and discussed briefly.

The more serious difficulties cited are: first, the operation of a single type of airplane from points at altitudes as great as 6400 ft. as well as at sea level, together with the fact that, in the case of this particular line, the heaviest loads are carried between the points of greatest altitude; second, the proper design of cowling and manifolding for the operation of the air-cooled radial engine at the extremes of temperature that are encountered throughout the year; and, third, the need for an engine that is geared down to the propeller or an engine delivering its normal power at a lower engine-speed.

Minor problems listed are: first, the proper manifolding for the air-cooled engine to serve as a muffler, to prevent flare at night, and to provide a means of heating cabins and cockpits; second, the arrangement of the airplane to facilitate quick servicing and loading as well as safety for the crew and passengers; third, proper positioning of fuel tanks; fourth, design of the landing gear; and, fifth, the operation of the landing lights.

Possible solutions for the difficulties are stated, and the results of operation or preliminary experiment, so far as they have been carried, are discussed. Brief comparison is made of the relative advantages of the monoplane and the biplane for transport service.

Discussion relates to the substitution of a wheel for the tail-skid and to details of racing airplanes.

ONLY within the last 2 years has commercial air-transport on a large scale in the United States been able to maintain itself. Such lines as have been organized and operated have been forced by necessity to use aircraft which, generally, were designed for some other purpose and were converted for transport use. Aircraft designers had no opportunity to study the problem at first hand because there existed no active demand for airplanes designed for commercial use only. Now that commercial air-transport is a reality, designers are finding themselves handicapped by a lack of knowledge. A large part of the experience gained in military aeronautics is not applicable to the strictly commercial airplane, but, on the other hand, much that will be learned from commercial operations will be of value in the designing of future military aircraft.

When Boeing Air Transport, Inc., was awarded the contract for the Transcontinental Air Mail route between Chicago and San Francisco, it was decided to equip this line with planes that were more modern than the remodelled observation planes such as those used by the Post Office Department. In 1925, the Boeing Airplane Co. had developed for the Air Mail Service an airplane which seemed to be excellent for the purpose except that the monocoque wooden fuselage would not stand up under the severe conditions met with in the daily service over the transcontinental route. Upon the award of this mail contract to the air-transport company, the Boeing Airplane Co. was given the task of building 25 new airplanes and delivering them along the line, ready for service, between Feb. 1 and midnight of June 30. As the time was exceedingly short, it was decided to use wings of the same design as were used on the original mail plane. The rest of the design was to be entirely new. The fuselage, tail surfaces and landing gear were to be built of steel tubing, the original biplane wings being of the familiar wood-and-wire construction. The covering of the planes was to be entirely of fabric. Instruments and equipment were to be the best that could be bought, and only such equipment was considered as

[1] Chief engineer, Boeing Airplane Co., Seattle, Wash.

had had some sort of service test by the military or naval services, or by the Post Office Department in its operation of the transcontinental line.

Fig. 1 is a side view of the airplane, and Fig. 2 shows the airplane in flight over the City of Seattle.

Mr. Hubbard, who was to be in charge of the operation of the line, insisted that it would be unwise to consider the water-cooled engine, because of the excessive weight of the installation and because of the experience had with the commercial lines operating in Europe, which was that approximately 25 per cent of their engine troubles had been with the cooling system. Of air-cooled aircraft-engines developed in this Country, only one of sufficient power, the Pratt & Whitney Wasp, was being produced in quantity, and it was the only one of high power that had been given any sort of reasonable service tests. These so-called service tests were of military planes only, and were, for the most part, made in flights at the Navy experimental stations. In addition, one Navy single-seater fighter, equipped with this engine, had been flown from the City of Washington to San Diego, Cal., to Seattle, Wash., and back to the City of Washington; and another had made the trip from Seattle to San Diego and return. It was felt, therefore, that this engine gave at least good promise of being reasonably satisfactory on the severe run from Chicago to San Francisco.

Route Presents a Laboratory for Research

This particular route probably presents wider extremes of conditions than any airline in the world. The altitudes of the various landing-fields vary from sea level to approximately 6400 ft. Part of the route is flown over flat prairie country, the other part is over mountain ranges that force the planes sometimes as high as 15,000 ft. Ground temperatures in the summer may run as high as 130 deg., and in the winter they may drop as low as 45 deg. below zero. The route from Cheyenne, Wyo., to Chicago is flown at night, although that portion of the line between Salt Lake City and Cheyenne is lighted to guide pilots on delayed trips and at the close of the short days of the winter season, as well as on dark mornings, because the westbound plane leaves Cheyenne at 4:45 a. m. The route thus presents an excellent laboratory for practical research on the problems of commercial air-transport.

Fig. 2—The Boeing Mail Plane in Flight over the City of Seattle

Boeing Air Transport, Inc., has been operating only 3 months, but in that time a number of problems have presented themselves, some relatively easy of solution, others presenting serious difficulties. The object of this paper is to state a few of these problems, as illustrated by the specific airplanes used, and to discuss each more or less in detail.

The difficulty that presents itself at once is that of providing an airplane that can carry the required loads

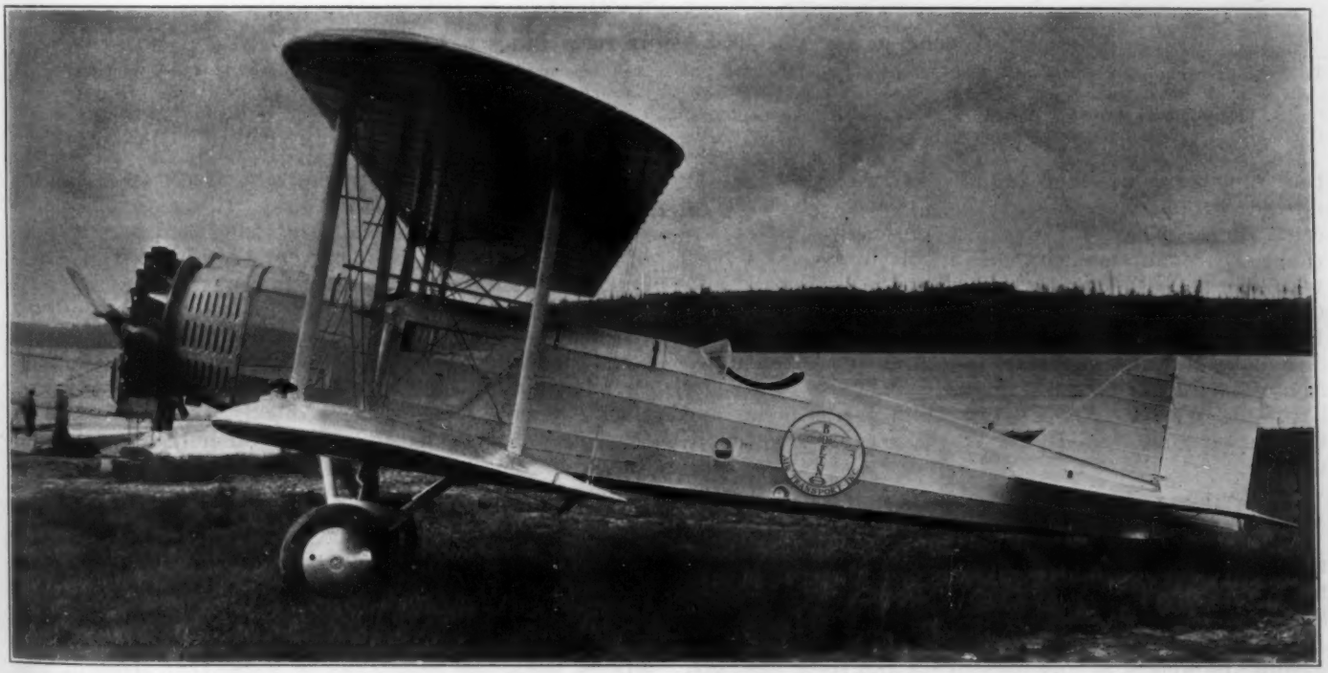


Fig. 1—Type of Airplane Used for Carrying Mail and Passengers on the Chicago-San Francisco Airline

It is a Boeing Plane, Powered with a Pratt & Whitney Wasp Radial Air-Cooled Engine. Successively Back of the Engine Section Are One Mail Compartment, a Passenger Cabin Directly over the Center of Gravity, a Second Mail Compartment, and Then the Pilot's Cockpit. Twenty-four of These Planes Were Designed, Built and Delivered to Their Proper Stations along the Line in 5 Months

successfully over all portions of the route and still have speed sufficient to meet the schedule, even under adverse weather and wind conditions.

Fig. 3 is an approximate profile of the route. It is difficult to make this profile exact because, in certain sections of the mountainous country, departure of a mile or two from the specified route, making use of passes in the hills, would give a profile with a somewhat different appearance. Eastbound, leaving San Francisco, the short trip to Sacramento can be made at any altitude, depending upon atmospheric conditions. Within 100 miles of Sacramento, the ship must clear a minimum altitude of 8000 ft., which is the elevation of the pass in the Sierra Nevada Mountains. If this pass is obstructed by clouds, as is often the case, it is necessary to ascend to an altitude of 13,000 ft., or even 15,000 ft., to be certain of clearing the peaks of the range. On the other side of this range, the airplane drops into Reno, Nev., at an altitude of 4500 ft. The next stop is Elko, Nev., at an elevation of 5060 ft. Between these two places are ranges of mountains with maximum elevations of 8000 to 10,000 ft., although, by following the passes, an altitude of 7000 to 8000 ft. is safe for flying. East from Elko, there are a few ranges, after which the line crosses Salt Lake Desert and enters Salt Lake City at an elevation of 4400 ft. Into Salt Lake City come also two feeder lines, the Western Air Express from Los Angeles and the Varney line from Pasco, Wash., serving the Northwest.

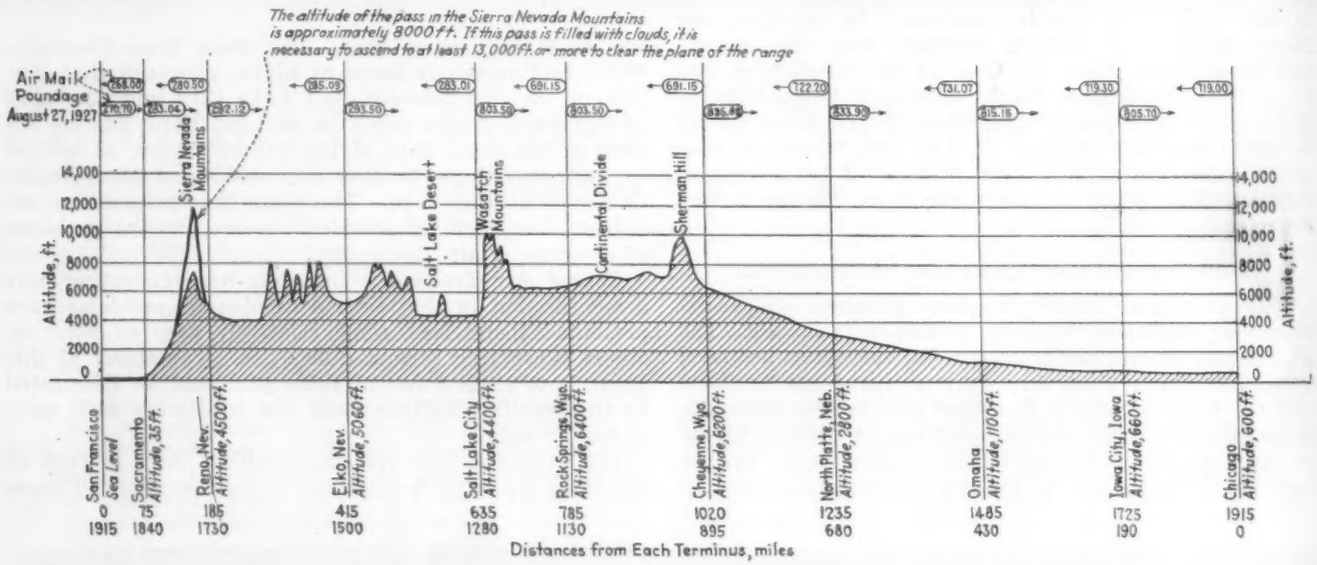


FIG. 3—PROFILE OF THE AIR-MAIL ROUTE FROM CHICAGO TO SAN FRANCISCO

This Gives Some Conception of the Difficulties Involved in the Operation of the Line. From San Francisco to Cheyenne, Wyo., the Airplanes Pass from Sea Level to Altitudes of Approximately 10,000 Ft. To Cross Several Mountain Ranges. When the Passes Are Obscured by Clouds, It Sometimes Becomes Necessary To Ascend to an Altitude of 12,000 to 15,000 Ft. The Heaviest Mail Load Is Carried from Cheyenne East, Although the Loads on the Highest Part of the Route Are But a Few Pounds Less

HEAVIEST LOADS CARRIED AT GREATEST ALTITUDE

Reference to the specimen poundage-figures given on the profile will show that out of Salt Lake City there is taken a load which is almost the heaviest on the entire line. The load carried eastward out of Cheyenne usually is but a few pounds heavier. These loads do not include the weight of any passengers and their baggage. As a rule, one passenger is carried, and about half the time there are two. This gives an additional 300 or 400 lb. Taking off at the altitude of 4400 ft., the plane must attain an altitude of 10,000 ft. in a distance of about 40 miles, to clear the Wasatch Range. The next stop, at Rock Springs, Wyo., is at an altitude of 6400 ft. and is the highest regular stop. The emergency field at Rawlins, Wyo., is higher, having an elevation of approximately 8000 ft. Leaving Rock Springs, it is necessary to fly at about 7000 or 8000 ft. until within 100 miles of Cheyenne, Wyo., when it is necessary to go to 10,000 ft. to clear the Laramie Mountains at Sherman Pass. Cheyenne lies at an altitude of 6200 ft. From Cheyenne eastward, the route is over country that is substantially flat, the elevation decreasing to 2800 ft. at North Platte, Neb., 1100 ft. at Omaha, 660 ft. at Iowa City, and 600 ft. at Chicago.

This detailed description of the route is given to outline the problem confronting the designer. Inasmuch as the heaviest loads are carried from Salt Lake City eastward, and as this is also the highest part of the route, it seems that either the airplane to be used over the whole route must be designed for this particular set of conditions, if it is to be successful, or that two different types of airplane must be used; one for the line east of Cheyenne and the other from Cheyenne west. It is interesting to note, however, that this line is the shortest between New York and San Francisco, as the great-circle course between these two points passes through Chicago. In addition to being the shortest line across the continent, it runs through more thickly populated areas of the United States than would any other transcontinental line, and, in consequence, serves the existing business centers best.

ALTERNATIVE CHANGES FOR ALTITUDE WORK

For an airplane of the type now in use, the rate of climb at 6000 ft. is only 60 per cent of that at sea level, and the landing speed is about 10 per cent greater. But in extremely hot weather, or with unfavorable wind conditions, the actual results can be worse than these figures would indicate. Assuming that the performance of the plane is satisfactory at sea level, to make it equally so at an altitude of 6000 ft. with the same load it will be necessary to do one or all of three things: (*a*) super-

FIG. 4—COWLING ADOPTED TEMPORARILY FOR SUMMER USE
This Is the Type Used on the Boeing Navy Fighting Planes, but It was Found To Be Too Complete for Operation in the Summer between Chicago and Cheyenne. It Was Necessary To Remove the Circular Nose-Piece

charge the engine to 6000 ft.; (*b*) increase the span loading, that is, the square of the span divided by the weight of the airplane, within the limits of economical structure; (*c*) increase the wing area.

In the Boeing mail plane, both (*b*) and (*c*) might be accomplished by increasing the span 10 per cent, leaving the chord the same. This would necessitate also a slight increase in rudder area. To meet condition (*a*), the Pratt & Whitney Co. has proposed a comparatively simple solution, which is now being thoroughly flight-tested in Navy aircraft. The Wasp engine has incorporated in it a rotary induction system, with the blower geared normally 5 to 1. By increasing this ratio to 10 to 1, it was found that the engine apparently is supercharged to approximately 5000 ft., with an increase in service ceiling, for the military pursuit airplane, of approximately 4000 ft. Since this change is accomplished without increase in weight, it is one of the rare instances in which the airplane designer gets something for nothing. However, care must be used in operating this engine at altitudes below 5000 ft., and it is necessary to provide a throttle stop to prevent the engine being opened-up to full power. An additional disadvantage for small-altitude work is that, for operating at full power at 5000 ft., a propeller large enough to absorb the full power of the engine at 5000 ft. will be required. This propeller will not turn up properly in the denser air at the lesser altitudes unless the blade setting is made so small as to render the propeller very inefficient.

One question that will present itself is that, if it is difficult to cool the present engine when operating in the summer months, will it not be more difficult to cool it in the supercharged condition? High ground-temperatures are encountered at Salt Lake City and Cheyenne in the summer, and these are the points between which it is desired to use this equipment. The answer seems to be that it will be more difficult to cool the engine, but definite conclusions can be reached only after trial.

ENGINE AND PROPELLER SPEED TOO GREAT

Another serious difficulty lies in the fact that, for single-engine tractor airplanes, which are by far the most economical type, the modern American engines of 400 or 500 hp. deliver their power at a rate of rotation that is much too great. The cargo plane, by its very nature, requires a fuselage of a cross-section considerably larger than cross-sections used in military craft. The result is that the large fuselage immediately behind the relatively small propeller necessary on the high-speed engine reduces the propulsive efficiency to an extent that is little short of discouraging. For example, the maximum cross-section of the fuselage of the Boeing Navy fighter F2B-1, mounting the Wasp engine, is 10.23 sq. ft. and the optimum diameter of the propeller is 9 ft. The ratio of propeller disc area to fuselage cross-section, which for convenience will be referred to as the "propeller interference constant," is 6.22 to 1. On the Boeing mail plane the maximum cross-section of the fuselage is 13.35 sq. ft., with an optimum propeller diameter of 9 ft. 3 in. In this case the propeller interference constant is 5.02. The reason, therefore, for an appreciable decrease in the propulsive efficiency is at once evident. The extensive experiments conducted by Dr. Durand and Professor Leslie at Leland Stanford University show clearly the detrimental effect of a large body behind a propeller on the propulsive efficiency as compared with that determined for the propeller alone.

On the other hand, if the Wasp were geared 2 to 1, thus turning the propeller 950 r.p.m. at full power, the optimum diameter for the propeller on the Boeing mail plane would be 13 ft. and the propeller interference constant would be 9.92. These propeller diameters are theoretical, but are all taken from one chart to make the results comparable.

DIRECT-DRIVE SPEED OF 1400 R.P.M. THE LIMIT

Experiments conducted with geared propellers by the Army Air Corps at McCook Field have, in some cases, given surprising results. In the case of the LWF trans-

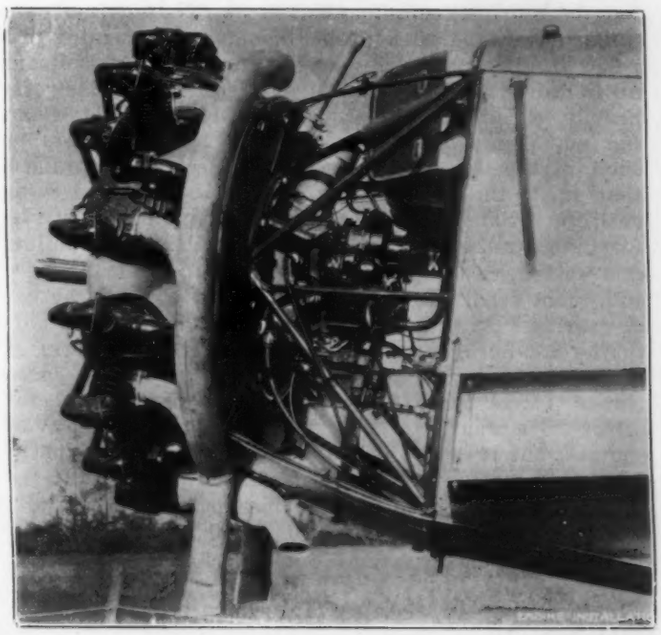


FIG. 5—EXHAUST COLLECTOR-RING AND CARBURETER HEATER
Cylinder No. 6 Has Its Exhaust Pipe Jacketed with a Stove and the Hot Air Is Led to the Carbureter-Intake Scoop. A Valve, Controllable from the Cockpit, Enables the Pilot to Regulate the Mixture of Cold and Warm Air. One of the Objections to This Arrangement Is that the Exhaust from the Bottom Cylinder Is Independent of the Collector Ring and Makes a Noise that Is Very Disagreeable for Passengers. Tests Have Shown that if the Engine Is Supercharged No Carbureter Heater Is Necessary

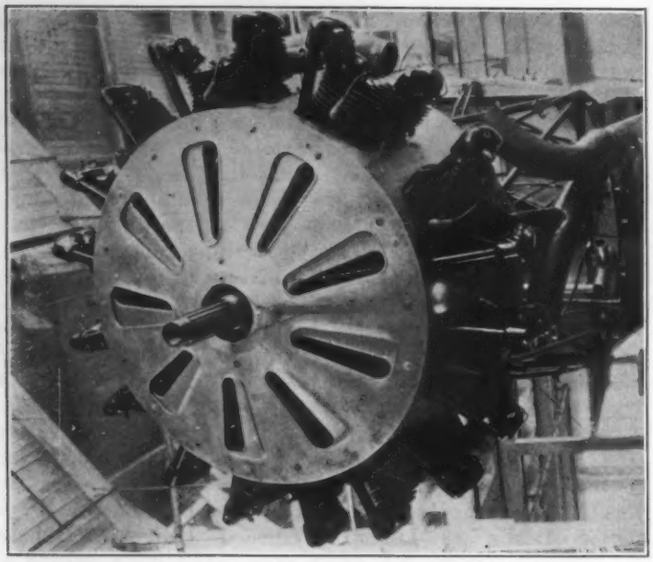


FIG. 6—COWLING WITH ADJUSTABLE LOUVERS FOR COLD WEATHER

The Inner Circular Plate Can Be Rotated by a Small Control Operated from the Pilot's Cockpit. Preliminary Tests Indicate that the Oil Temperature Can Be Raised 10 Deg. by Closing the Shutters. The Shape of the Cowling Decreases the Airplane Speed Approximately 1.3 M.P.H.

port T-3, having a maximum fuselage cross-section of 24 sq. ft., the use of a Liberty-12 engine geared 2 to 1 more than doubled the rate of climb, reduced the length of run for take-off almost one-half, and appreciably improved the high speed in level flight. It is significant that the new Curtiss Condor bomber, which has shown excellent performance, mounts geared engines. The Navy has long been using geared engines in its PN-10 flying-boats.

The advantage of the large-diameter slow-turning propeller in giving a shorter length of run for take-off and an improved rate of climb is too great, particularly for heavily loaded commercial planes, to be neglected. Gearing now seems to be the only solution, but gears on such high-powered engines are a mechanical problem that, up to the present time, has not been solved in an entirely satisfactory manner. A promising substitute for the geared engine is found in the Fairchild-Caminez cam engine, in which a propeller speed of one-half the equivalent crankshaft speed is obtained without the use of gearing. At present this type of engine is built only in the 135-hp. size; whether it would be successful in large sizes remains to be seen. But, for use in cargo planes, I feel that 1400 r.p.m. is the upper limit for direct-drive engines. This means larger and heavier engines, but it is felt that the advantages outweigh the disadvantages for this particular class of work. If the mail plane had an engine of this speed, the optimum propeller diameter would be 10 ft. 10 in. and the propeller interference constant would be 6.9.

COWLING FOR WEATHER EXTREMES A PROBLEM

The next big problem that presented itself was that of cowling for the air-cooled engine; a cowling which would streamline the ragged engine as much as possible and at the same time interfere as little as possible with proper cooling. A study of European airplanes, in which the air-cooled engine has been used for some time, gave little help, because the range of cowling designs varied from the one extreme, such as enclosing the engine completely, placing the "crusader" hoods over the cylinder-heads, to the other extreme of leaving the engine completely exposed and carrying the cowling down to the mounting plate behind the engine.

For the mail plane, it was decided to adopt the type of cowling used on the Navy X-F3B, a single-seater fighter built by the Boeing Company. This type of cowling, as installed on the mail plane, is illustrated in Fig. 4. It was felt that, as the first few months of operation would be in hot weather, this type of cowling would serve and give time to develop a different type for use in winter. It was found, however, that even the cowling installed was too complete for operation in the hot season, in particular between Cheyenne and Chicago, and it was necessary to remove the circular nose-piece and, in some cases, the pieces between the cylinders. The use of a very heavy oil in the engine was also found necessary. A set of experimental cowling which was carried to the engine mounting ring, thus leaving the engine entirely exposed, was found to be no better for cooling than the original set without the nose-piece, and to give a decrease in speed as well.

CARBURETER STOVE FOR ZERO TEMPERATURE

For winter operation, we have only the experience gained from the Navy fighters using this same engine. It was known that, for operation at air temperatures around 0 deg. fahr., it would be necessary to supply heated air to the carbureter. To do this, the exhaust pipe from the No. 6 cylinder was jacketed with a stove, the heated air from this being led to the carbureter-intake scoop. A valve, controllable from the cockpit, enabled the pilot to regulate the mixture of cold and warm air supplied to the carbureter. This heater is shown installed on the mail plane in Fig. 5. While the heater is the best that has been built to date for this engine, it is far from satisfactory, and the Pratt & Whitney engineers, as well as the Boeing organization, are working on the problem. One objectionable feature in this arrangement of the heater is that the exhaust from one cylinder, being independent of the collector ring, makes sufficient noise to be decidedly unpleasant for passengers riding in the cabin and, for the comfort of passengers, this must be eliminated.

In Navy tests with the supercharged Wasp, it was found that no carbureter heater was necessary, even at the extremely low temperatures encountered at an altitude of 26,000 ft. This is an additional advantage for this supercharged engine, but it also indicates that the engine might give trouble at the ground in hot weather.

COWL WITH LOUVERS GIVES PROMISE

The cowling illustrated in Fig. 6 has been developed for cold-weather flying, and preliminary tests indicate that the oil temperature can be raised at least 10 deg. by closing the shutters. It is possible also to keep the oil at a fairly constant temperature for long periods with the engine throttled. The nose plate is rigid, and a second plate mounted inside of it can be moved by a small control operated from the pilot's cockpit. The nine louvers, one in front of each cylinder and of as large a size as the installation will permit, can be closed or opened as becomes necessary. It is hoped that this cowling, combined with the air-intake heater, will solve the problem of operation in cold weather, but, until tests under actual service conditions are obtained, no definite conclusions can be drawn as to the value of the device. It was found by actual runs over a speed course that this cowl, as compared with that illustrated in Fig. 4, de-

creased the speed of the airplane approximately 1.3 m.p.h.

Difficulties Presented by Exhaust Manifold

Next came the problem of the exhaust manifold. In the V-type engine, with the exhaust ports all in a line, manifolding is relatively easy. With the radial air-cooled engine, the ports are in a circle almost as large as the outside diameter of the engine, and any collector ring placed there lies broadside to the air-stream, with the consequent additional resistance. On the military airplanes using this engine, a small individual stack is fitted on each cylinder. On the transport airplane, however, they will not serve, because the exhaust manifold must

(1) Eliminate the flash of the exhaust, which, if present, makes night flying in misty weather a hazardous undertaking by blinding the pilot
(2) Muffle the engine to whatever extent is possible. This is essential for the comfort of the passengers, and it lessens the strain on the pilot
(3) Be jacketed by a stove in cold weather, to provide heat for the passenger cabin, the pilot's cockpit and for the carbureter air
(4) Conduct all exhaust gases away from the passenger cabin and the pilot's cockpit

European air-transport practice is almost universal in the adoption of the collector ring terminating in a single or double long pipe under the fuselage. In the case of the Boeing mail plane, one disadvantage of such an arrangement is the location of a gasoline tank in the body. A certain amount of the fuel is almost always spilled when the tanks are filled, and the possibility of this falling on the manifold creates a rather definite fire hazard. This is minimized, however, by placing the manifold under the fuselage on the side opposite to that on which the filling is done.

The collector ring manifold has several disadvantages:

(1) It is known to be a definite fire hazard in the event of a crash where gasoline can be spilled on the engine. The manifold can, however, be cooled to some extent by placing a scoop on it, thus forcing a stream of cold air into the exhaust gases. This also assists to some extent in eliminating the flash. Fig. 7 shows an experimental manifold unit with such a scoop incorporated
(2) It adds considerable weight to the airplane
(3) It increases the resistance of the airplane because it cannot be placed inside the cowling and should not be laid flat on the outside of the cowling. A stream of air should flow around it to keep it as cool as possible. Tests show that the manifold illustrated in Fig. 4 causes a loss in speed of approximately 3 m.p.h. as compared with the speed of the plane when the engine is equipped with short individual stacks

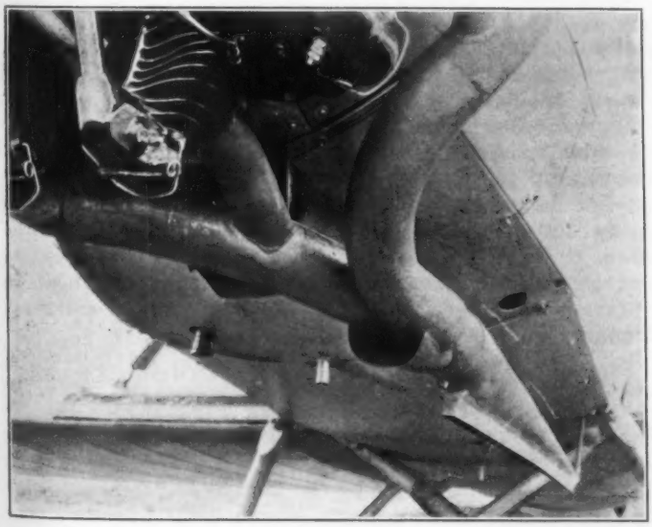


Fig. 7—Experimental Manifold Unit with an Air Scoop

This Is an Experimental Type of Collector Ring and Exhaust Stack. The Air Scoop Shown at the Intersection of the Two Pieces of the Collector Ring Serves To Reduce Back-Pressure, To Give a Cooler Exhaust-Stack and To Reduce the Flare at Night Appreciably

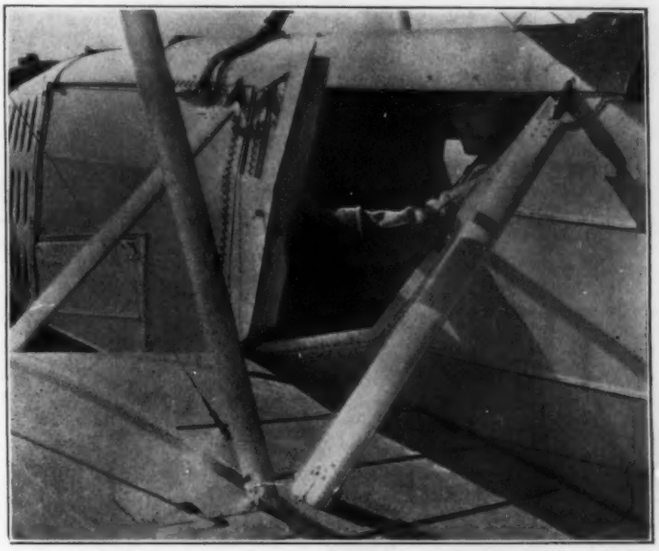


Fig. 8—Left-Side Door of Passenger Cabin

This Door Was Made Larger than the Right-Side Door but This Construction Is a Mistake, as Passengers Entering or Leaving the Cabin Interfere with Men Loading and Unloading the Mail from the Front or the Rear Mail Compartment. Passengers Usually Wish To Get Out and Exercise a Bit during Stops

The manifold shown installed in Figs. 4 and 5 is used at present on the Boeing mail planes. It is not satisfactory because it does not prevent flashing at night. It muffles the engine to some extent and does keep exhaust gases out of the passenger cabin. The diameter of the collector-ring is 3½ in., and it was feared at first that it would cause too much back pressure; but by actual test, this was found to be 0.4 in. of mercury at full throttle, which pressure occurred at the upper end of the ring. The Pratt & Whitney engineers stated that 1 in. of mercury was the maximum allowable back pressure.

Cabin heating is accomplished by stoves placed around the short stacks at the bottom.

Interior Arrangement of the Mail Plane

Aft of the engine section of the mail plane shown in Fig. 1 is a mail compartment. Back of this and just over the center of gravity is a passenger cabin, aft of which is another mail compartment, then the pilot's cockpit.

In practically all European transport-airplanes the pilot sits directly behind the engine. While this position affords him better visibility and simplifies the controls leading to the engine section, it has the two disadvantages that (*a*) the problem of proper balance for both

the full-load and empty conditions is troublesome, and (*b*) the danger to the pilot in the event of a crash is acute. For night flying and for flying with bad weather conditions in mountainous country, most of the Air Mail pilots prefer to sit far aft.

The disadvantages of the position aft are that (*a*) all controls to the engine section must be carried forward under the floor; (*b*) visibility is not so good as it should be, although in this case it works out fairly well, particularly as an adjustable seat is provided; and (*c*) it is difficult to heat the cockpit properly.

In an airplane with as many controls as are necessary on the mail plane, the location of the engine-section controls under the floor creates a very troublesome condition, although the use of Ahrens control-units eliminated much of the work and maintenance trouble incidental to the use of bellcranks.

The use of two mail compartments serves two purposes: (*a*) the load can be balanced properly, as the weight is on either side of the center of gravity, and (*b*) two men can work at unloading from the two widely separated compartments. This last is a feature that assists greatly in reducing the time necessary to handle the mail at the stations.

The mail compartments open on the left side of the airplane. Although the passenger compartment has a door on either side, the one on the left, shown in Fig. 8, was made larger than the other, as it was intended to have the passengers enter and leave from that side. This was a mistake. When a stop is made, the passengers usually wish to alight and walk about a bit, and when they leave or enter the cabin on the left side, they interfere directly with the man loading or unloading mail at either one or the other compartment. In the future, when similar airplanes are designed, arrangements must be made so that this interference will not occur.

Folding Steps To Aid Mail Handling

Fig. 9 illustrates the use of a device that was incorporated in the design to facilitate the handling of the cargo from the front mail-compartment and also to serve as a platform from which to reach the engine section. The engine is so high above the ground when the tail of the airplane is resting on the ground that some sort of ladder or platform is necessary. In case of trouble with the electric starter, the engine must be cranked from this position. The platforms are hinged and fold into the fairing on either side of the body, where they are held by spring fasteners. These springs, incidentally, were not made of sufficient strength in the first design, and allow some of the steps to open while the airplane is in flight. There is no objection to this except that the steps offer added air resistance. The steps were designed to support two men, but it was found that the designer had not taken account of the existence of some very active, heavyweight mechanics, and a few of the steps have folded up in a way that was not intended. They are now being reinforced.

Wings Seem Best Place for Fuel Tanks

The question of fuel-tank location is a troublesome one. Obviously, the tanks should be placed where the fire hazard is least, and this generally takes them out of the body. The tank in the fuselage of the Boeing mail plane was retained because sufficient time was not available to alter the installation used in the original mail plane.

Placing the tanks in the wings seems to offer the best solution. If they are placed in an upper wing, they afford the advantage of gravity feed but present the disadvantage of being awkward to fill. Mechanics generally stand on the fuselage to fill the tanks and, unless the cowling is heavily reinforced, it becomes badly deformed. Upper-wing tanks give a high center of gravity with the attendant danger of the airplane nosing over when landing on rough ground.

Tanks placed in the lower wing of a biplane offer the best conditions for servicing because this can be accomplished quickly, and any spill runs onto the ground instead of sprinkling the entire plane. But, with tanks in the lower wings, a reserve gravity tank with a capacity of at least 15 gal. is required in addition, which means extra piping and weight and three tanks instead of two to fill. Speed in servicing is of special importance for airlines operating on schedule. On the line from Chicago to San Francisco, the schedule allows only 10-min. stops at intermediate stations. Mail must be handled, the airplane must be serviced and, so far as possible, inspected in this time. Hence the gasoline tanks must be readily accessible and so vented that they require the minimum of time for filling them.

Landing Gear Requires Special Attention

Special attention should be paid to the landing gear. Three features are essential, particularly for operations over terrain of the character traversed on certain parts of the Chicago-to-San Francisco route. These are, (*a*) the cross axle must be eliminated, (*b*) the shock absorber should be of the oleo type, and (*c*) brakes for the wheels, controllable either individually or together, must be provided.

In one forced landing between Salt Lake City and Reno, a cross-axle landing-gear would have resulted in at least a nose-over, because of large clumps of sage brush. As it happened, no damage was done.

The oleo shock-absorber eliminates much of the bouncing which is characteristic of a rubber gear, and permits the making of stall landings that would be impossible with the conventional rubber device, a fact that is particularly advantageous in short fields or in fields located at greater altitudes.

The advantage of brakes for shortening the roll after landing, and of the use of individual brakes for making short turns on the ground, is obvious. If the airplane is equipped with the electric-inertia starter and the brake controls are constructed so that they can be locked, the pilot can start his engine, run the airplane up and turn it into position for take-off without assistance. Features in the design of the airplane which serve to eliminate the necessity for a large ground-force are valuable, as they tend to reduce operating costs.

The landing-gear structure should be designed with generous factors of safety, even though it seems at the time to involve useless excess weight. The small amount of excess weight carried more than pays for itself in preventing general damage resulting from a collapsed landing gear.

Controllable and Retractable Landing Lights

The standard landing-lights for night flying, as developed by the Air Corps of the Army, have not been entirely satisfactory, primarily because, as designed, they are not controllable by the pilot as to position. Some pilots contend that the lights should be arranged so that the direction of each light in a vertical plane would be controllable by the pilot in flight, as it is often desirable to have one light pointing straight downward to assist in seeing objects on the ground and to facilitate holding the course. Then, for landings, the lights could be

brought up to the normal position of approximately 10 deg. below the longitudinal axis of the airplane.

A further criticism of the lights, as installed on the under side of the wing, is that they are responsible for too great a decrease in speed. They reduce the speed of the Boeing mail plane by 3.8 m.p.h. The only remedy for this is to retract the lights into the wing when they are not in use. One company has done this, but I understand that the lights are not adjustable. Both adjustments could, however, be made by the use of one control for each light.

That these adjustments are necessary cannot be denied; anything that seems to make the job easier for the pilots on the night runs is well worthwhile, particularly when an increase in performance will result. The difficulties lie in the fact that two more controls must be added, and these must extend forward in the bottom of the fuselage and out into the wings, with connections which can be broken easily in event of dismantling the airplane. This means added weight and complication, with increased maintenance troubles. In the cockpit of the present Boeing mail plane are 12 manual controls, aside from the stick, rudder-bar and the light-switches; and of these, 10 carry forward under the floor. These are the gasoline hand-pump, the stabilizer adjustment, the throttle, the spark lever, the mixture control, the gasoline shut-off valve, the brakes, the nose-cowl shutters, the starter clutch, the pressure fire-extinguisher, the carbureter air-heater, and the parachute flares.

Incidentally, the parachute flares, with their mudguards, cut an additional 1.4 m.p.h. from the high speed, but there seems to be no simple way of eliminating these and maintaining a positive and safe release for the flares.

Installing two more controls, one for each light, will not simplify matters any, but the assistance to the pilot, and the increased performance, are of such importance that the details of this installation are now being studied.

Relative Advantages of Monoplane and Biplane

Study of the designs for transport airplanes in Europe and in the United States indicates that a time-honored debate is still in progress as to the advantage of the monoplane over the biplane, or vice versa. English designers have favored biplanes almost exclusively, the latest exception being the Handley-Page Hamlet. This airplane is more of a sport plane than a full-fledged commercial transport. In France, one type seems to be as much in favor as the other, while in Germany the monoplane seems to predominate, although some very capable German designers adhere to biplane construction.

The choice between the two types of construction seems to be largely a matter of personal preference, as well as the particular type of work to be accomplished. Aerodynamically, there is but little to choose between the two, provided the biplane is properly designed. Chief advantages of the monoplane over the biplane are:

(1) Greater simplicity, as it has fewer parts
(2) The high-wing monoplane affords better visibility for passengers
(3) The wing of a high-wing monoplane is less liable to damage from obstacles on the ground, such as fence posts and stumps

The advantages of the biplane are:

(1) The wing cellule, in general, has less weight per square foot than the monoplane
(2) The wing structure is more rigid, and errors in rigging are more easily corrected
(3) The wings are made up in sections and are more easily handled and stored

This last feature is one to be considered carefully for

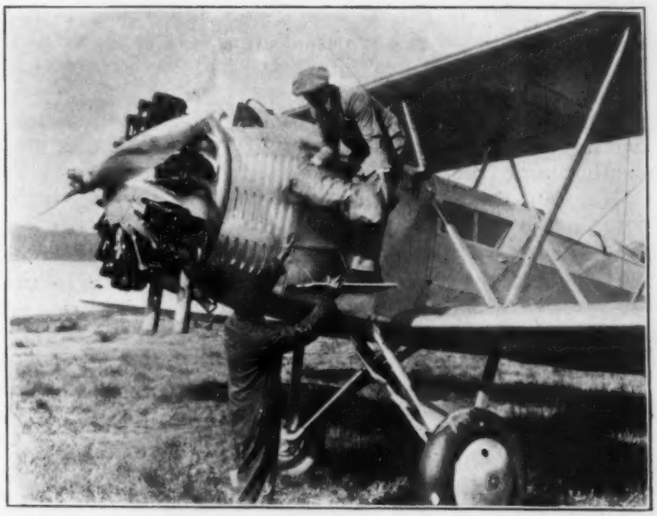


Fig. 9—Unloading Cargo from Forward Mail Compartment

The Platform Shown Is Hinged So As To Fold into the Side of the Body. The Platform on the Right-Hand Side of the Plane Is also Useful when Cranking the Engine by Hand in the Event of Failure of the Electric Engine-Starter

airplanes operating over long stretches of desolate country. For example, the forced landing of one of the Boeing mail planes, mentioned in the discussion of the landing gear, was made in what is practically desert country. The nearest town was about 12 miles away, and the only way to reach the ship with repair parts was by truck. If a wing had been damaged in landing, a spare panel could have been loaded in an ordinary truck such as would be available in a small Western town, and the replacement could have been effected by three or four men. On the other hand, the transportation of a single-piece monoplane wing for an airplane of this weight would have been a difficult job, to say nothing of hoisting it into place once it had been delivered to the airplane.

The difficulties mentioned are the major problems that have confronted the Boeing Air Transport, Inc., in its operation of the western part of the Transcontinental Air Mail line, but a number of other minor ones are constantly arising to be met and solved as completely as possible. The major problems discussed are, however, the ones that should be studied by the designer before he designs equipment for any given line of air transport. These are, (*a*) the nature of the terrain, (*b*) the altitudes to be attained with full load, (*c*) weather conditions, (*d*) the types of powerplant and other equipment available for his purpose, and (*e*) the proper interior arrangement of the airplane to suit the particular kind of service to be rendered.

THE DISCUSSION

Question:—Has Mr. Monteith considered the substitution of a wheel for a tail-skid?

Charles N. Monteith:—Yes. The tail-skid is satisfactory on a mail plane because the load is such that it makes little difference whether a wheel or a skid is used; but on a large craft weighing 13,000 to 14,000 lb. the wheel skid is almost essential. For a load of 14,000 lb., an ordinary tail-skid causes too great a drag on the airplane and makes it too difficult to get the plane under way. The objection to a wheel to replace the tail-skid is that of proper control; but by using brakes it is believed

that the difficulty can be overcome. We expect to use the wheel tail-skid in our new designs. It is to act as a caster through 180 deg. of travel and we expect that brakes will steer it properly.

QUESTION:—Would it be possible to erect a simple derrick on a motor-truck to simplify the problem of unloading mail from the plane?

MR. MONTEITH:—The proposition of using a single container has been made but it is said that it is preferable to drag the mail out of an airplane piece by piece so that the individual sacks can be checked at the time they are taken out.

ARTHUR NUTT[2]:—Regarding the racing airplanes that will compete tomorrow here in Spokane, they are really the standard observation and pursuit craft with modifications to give extra speed for this event. Two of them have our wing-type radiators, which we have used for the last 7 years. They consist of sheets of corrugated brass soldered together so as to leave longitudinal passages across the airfoil from one wing-edge to the other. In this way, the drag of the radiator is eliminated and the speed is increased from 10 to 20 m.p.h.

The engines in which I am concerned are a development from the D-12 engine which is being used in quantity by the Army in pursuit, attack and observation airplanes. This engine will drop into the same bed-bolt mounting as that of the D-12 engine, and it is an engine that has been under development for the last 3 years. Originally, we began with the idea of increasing the displacement of the D-12 engine. It had a 4½-in. bore and a 6-in. stroke, the displacement being 1145 cu. in. We changed the stroke to 6¼ in. and the bore to 4⅞ in. making the displacement 1400 cu. in. At this time the Packard Motor Car Co. developed its 1500-cu. in. engine, so we increased the new engine displacement from 1400 to 1550 cu. in by increasing the bore to 5⅛ in. on the same cylinder centers. We spent 2 or 3 years developing the engine.

The Condor, which has two engines with 2-to-1 gearing for making the propeller turn slowly on account of the relatively slow speed of the craft, does 130 m.p.h. when the throttle is opened full out, and the engines deliver 600 hp. as compared with the 440 hp. of the D-12 engine; hence, we have increased the power by about 50 per cent in the last 2 or 3 years with an increase in weight of about 50 lb. in the engine. About 85 lb. are added for the gears on the geared engine.

While we have not had long service-tests on the gears, we have run our gears through long periods of testing in the shop and have had no trouble with them. By the use of a certain type of spring-coupling to take off the shock, it looks as though the gear problem has been solved.

We have these two engines in service in the Condor airplane, and they have done over 50 hr. of flying at full throttle up to now without any trouble. Before the year is over, I believe the Air Corps will have had a sufficient number of hours of testing these gears in service to give us much more information.

The airplanes that are here have direct-drive engines with a higher compression-ratio, and develop about 735 hp. at the speed being used, which is by no means at the maximum peak of the power curve. The engines weigh 750 lb. and we are getting almost 1 lb. per hp. from them, not including the radiators. Including them adds ½ lb. per hp. and brings the total weight to 1½ lb. per hp. This weight-horsepower ratio compares well with that of the large-power air-cooled engine and is better than that of the 200-hp. air-cooled engine.

In accord with Mr. Monteith, I think the air-cooled engines are best for commercial work. We have been concentrating on the development of military airplanes and engines; but we will have the air-cooled engines for commercial work when the time comes that the demand is great enough so that we can go into production on such engines.

COMMANDER J. B. KNEIP, U. S. N.[3]:—Many features that enter into the design of aircraft are peculiar. One peculiarity is the difficulty of determining what is desirable. Certain problems concerning airplanes and their design may be discussed with the pilots and no two will agree. This constitutes a difficult problem. We have the contractor's viewpoint, the aviator's viewpoint and features of the manufacturing that necessitate consideration of the manufacturer's problems, such as how he can install certain instruments and equipment to agree with the specifications that the Navy requires.

I do not know of any industry, even including the automotive industry, in which such remarkable advancement has been made as in commercial aviation in the last 4 years. Much knowledge has been acquired through practical experience and also from the Air Service experiments. The Air Service has allowed whatever it has developed to be used to benefit commercial aviation; it developed the air-cooled engine and made it available for commercial aviation, and it has done many other things that benefit commercial aviation.

[2] M.S.A.E.—Chief engineer, engine division, Curtiss Aeroplane & Motor Co., Inc., Buffalo.

[3] Navy inspector, Boeing Airplane Co., Seattle, Wash.

Superior Railroad-Service

UNDOUBTEDLY, the railroads have won favor for themselves in the eyes of the public in the last 6 years by giving superior service in a more comprehensive way, that is, in a more National way, than they ever conceived it to be their duty to do before. But it would be well for us to pause and consider how much of that superior service has been made possible by the progress of the motorcoach and motor-truck in relieving the railroads, not only from some of the unremunerative short-haul traffic, but from a very large proportion of the traffic which before had congested the terminals and appropriated the cars and engines which might better be utilized in the long-haul service.—T. C. Powell, in an address before the Railroad Motor-Transport Conference.

Neglected Values of Time-Study

By J. Charles Mottashed[1]

Production Meeting Paper

Most time-studies are made with the object of reducing both time and effort expended to accomplish a given task. For this purpose it is essential that motion-study go hand in hand with or precede time-study. All the different systems of wage payment have felt the influence of these studies, but the value of time-study goes beyond the ascertaining of the piece price and of rate setting.

The scope and application of time-study have widened materially in the last decade, but many organizations have neglected to use in its wider applications the information it places at their disposal. The author sets forth the neglected "points of contact." Data obtained can be used for (a) *rate setting,* (b) *utilizing time wasted on another machine or operation,* (c) *ascertaining requirements for machines and for floor space,* (d) *regulating the flow of work in a progressive line-up,* (e) *determining the amount of inventory in raw material and material in process to be carried,* (f) *ascertaining the type and size of conveyors needed and the capacity of those already installed,* (g) *and for determining the number of men needed in each department for a given production schedule.*

TIME-STUDY and motion-study, though not the same, are so closely allied that, under most circumstances, we think and speak of them as one. A time-study may be made without paying any attention to the motions of an operation, or a motion-study may be made without regard to the time element. Most such studies are made with the object of reducing both time and effort expended to accomplish the given task; and for this purpose it is essential that motion-study go hand in hand with or precede time-study.

The different systems of wage payment have all felt the influence of time-study and motion-study. This applies even to straight day-work. As many, and sometimes as fearful, as these systems have been, running the entire gamut of day-work, straight piece-work, group bonus, gang piece-work, premium and differential, it is not my purpose with regard to the relation of time-study to rate setting or wage payment to do more than touch upon it.

The scope and application of time-study have widened materially in the last decade, yet many organizations which have a fairly comprehensive time-study and rate-setting department have neglected to use the wider field of information that it places at their disposal. Time-study should touch the organization at many points; the function of rate setting is not its only important point of contact. My purpose is to discuss some neglected points of contact.

Study May Include Machine Capacity

The first point of contact is with rate setting by the usual time and motion study, in which the observer has entered the part name and number, the operation name and number, and the elapsed time for the operation; has made proper allowance for fatigue and contingencies, personal or otherwise, and has determined that the operation will take a certain number of minutes to perform. At this point the value of most studies ceases. A clerk divides the allowed time in minutes by 60 and multiplies the quotient by a given base rate and, lo, he has a piece price.

The value of the time-study need not cease with this. Most observation forms have but one column for the entry of elapsed-time figures. It is for entering the operator's time. The better type of study, while not ignoring the operator, also takes into consideration the equipment used; hence there are two columns, one for the man and another for the machine, and the difference between man capacity and machine capacity is shown clearly.

Although this difference does not affect the piece rate, it may indicate the possibility of utilizing time wasted on another machine or operation.

The second point of contact is the erection and maintenance of a machine load-file. Information relating to equipment, as entered on the time-study form, is carried forward to the machine load-file, which contains the part number and operation number, with the allowed time in hours expressed decimally, and a list of equipment numbers indicating the available number of machines of similar type. This machine load-file is of inestimable value and will save large sums of money from year to year. Even the smaller shop can profit by its use.

Assume, for example, that the management lays out for the next 6 months a manufacturing program that is 50 per cent more extensive than for the last 6 months; to increase the equipment by 50 per cent would be folly, yet who knows exactly how much to increase it, if any? A properly kept machine load-file, with flag signals indicating the machine capacities in completed units, will indicate quickly the equipment needed to carry the program through successfully. In this way the machine load-file prevents the purchase of surplus equipment or the wrong kind of equipment, and suggests the purchase of needed equipment and the right kind to buy.

Its influence goes further, in that it often will prevent the erection of unneeded buildings. With the information it contains on assembling on a conveyor, it may prevent a building from being built too short to take care adequately of the operation to be done on a conveyor.

In case of a breakdown, the machine load-file quickly indicates another machine that is available, or as quickly indicates the non-availability of a machine. This information can be used, not only for factory equipment with which we are all familiar, but for electric industrial

[1] President, Society of Time Study Engineers, Detroit.

trucks, elevators, conveyors, sewing machines, stone crushers, dredges, and, in fact, for equipment used in any of the many industries.

One of the great advances made in American industrialism is the development of the single-purpose machine, but the tendency now seems to be toward general-purpose machines having complicated special-purpose fixtures. In a progressive line-up, more often than not, the single-purpose machine is a veritable nightmare, as it is either the neck of the bottle where congestion occurs or it is so fast that it throws all the rest of the line out of balance. A comprehensive machine load-file will be of great assistance in controlling this situation and will keep before the management the real capacity of the machine regardless of how it may be slowed down to accommodate the rest of the line.

Knowing the machine capacities, it is only a short step to determining machine requirements. Machines may be moved from one department to another with confidence. The purchasing department may purchase without fear the proper amount of new equipment and the right kind.

The third point of contact already has been touched upon. It is the information that is made available to the layout department, which determines the amount of floor space to be used for a given production, the number and length of benches, and the number and length of conveyors.

The fourth point of contact is the stores department, which can, through time-study information, determine the amount of inventory in raw materials and in materials to be carried in process. Even the size and shape of stock containers will be influenced by such information.

Intra-plant transportation is the fifth point of contact. The number, length and breadth of conveyors and the type best suited for the particular task, in the case of new installation, and the capacity of those already installed, can be determined from time-study information.

A sixth point of contact is the employment department. The time-study department should be able to place in the hands of the employment office information as to the number of men needed in each department for a given schedule, and requisitions for men can be governed by this.

Mobile Farm-Equipment Development

AN automobile engine or transmission or device that will function efficiently in Texas will probably function just as well in Maine, and so with a bridge, a pump, a steam engine, a lathe, or any article of shop equipment. It is vastly different with a mobile farm implement. Between Maine and Texas there may be a dozen or a score of variables in the contours, the soil, the climate, the crop, or the deep-rooted prejudices of the farmers that must be met in designing a farm implement for Nation-wide use.

The area of mobile operation may be irregular in contour and the ground may be soft, hard, stony, sandy, or sticky. There are hillsides to deal with, flat lands and valleys. The machinery is subject at all times to weather conditions, to heat, cold, moisture, and dryness. It is therefore obvious that the designer's viewpoint is distinctly different from that of one who meets indoor conditions where there are far less jolting and shock-producing operations and where expansion, contraction and resistance to rust seldom appear as important factors.

Take, for example, a 14-in. plow, set to cut 6 in. deep, and draw it at 3 m.p.h. In light sandy soil the dynamometer might read as low as 150 lb., whereas in gumbo it might read 1800 lb., under hard conditions.

The binder may meet grain 12 in. high or 6 ft. The grain may be standing up straight or it may be lodged almost flat, so that the knife must barely skim the ground. The wheat crop may be 3 bu. per acre or 40 bu., and special yields of 80 bu. are met. The same machine must handle one extreme as well as it does the other.

The grain drill may be required to deposit evenly anywhere from ½ to 4 bu. of seed per acre. Sowing oats might mean the planting of 15 lb. per acre minimum and barley may require as much as 340 lb. per acre.

What would be the effect on a farmer if his grain binder missed tying a few bundles per hour? The binder must tie with a permissible miss of only a fraction of 1 per cent, in spite of the difficult physical variations. When the knotter is in good order, when no fault can be found with the twine as to size and strength, one can count on not over 1 miss to 1000 bundles. Whole days of operation are recorded without a miss.

Handling the Farm Product

In addition to these variable field conditions, it should be remembered that we are in most cases dealing with a peculiarly light-weight product which is delicate to a considerable degree. The ripe grain in the field must not be too roughly handled or shattering results, with accompanying wastage. Such crops as peas or beans are particularly susceptible to injury in harvesting. If grain is handled by the thresher cylinder at too high speed, cracking results with loss in grading. If threshed too slowly, grain will not be removed and will be blown into the stack with noticeable loss. Similar delicacies must be considered when applying machinery to handling corn, beets and potatoes. Undesirable bruising, skinning or other injury affects the keeping value as well as the salability.

If the entire range of machinery as applied to agriculture be reviewed, one cannot fail to see the extremes in fine and coarse construction which must be met.

In operation, the plow is a rigid unit. It must enter the ground to a predetermined depth, cut, raise, turn, reverse, and place a strip of soil, while at the same time it must cleanly and accurately cover trash, fertilizer, weeds, or other litter. In its highest form the plow today is but a play tool for the farmer, who, seated comfortably on the tractor, simply jerks a string to set his plows in the ground automatically, or likewise lifts them.

As we review past developments, comparing the spade and ancient crooked-stick plow with the modern tractor gang-plow, the brush drag with the modern harrow and pulverizer, the hand hoe with the high-speed tractor cultivator of today, the sickle with the harvester-thresher, it is evident that much progress has been made in the application of machinery to agriculture, but it must be apparent to the student who views our industry from the outside as it is to us on the inside that only a beginning has been made. The field is wide and it is full of invitation and of challenge.—O. B. Zimmerman before the American Society of Mechanical Engineers.

Fire Hazards Incidental to the Spraying of Flammable Finishes

By H. L. Miner[1]

PRODUCTION MEETING PAPER

As the extensive introduction of pyroxylin finishes and of spray painting was almost simultaneous, there has been some confusion as to the reason for the increase in fire hazard. The author shows that the process rather than the material is the controlling factor.

Catalytic action of copper is presented by tabular data as an interesting phase of the fire hazard, and this is supported by experience narrated in the discussion.

Adequate ventilation of spray booths and good housekeeping are named as prime requisites for safe operation of a spray finishing department.

FEW problems in the industrial world in recent years have attracted so much attention as the application of finishing materials by the spray method. No other problem has developed so many diversified opinions, many of them entirely erroneous, largely based on personal conclusions without sufficient knowledge of facts. These statements or conclusions have been responsible for either over-emphasis of the fire and the health hazards involved, or slighting and mitigating the hazards so that proper precautions have not been taken.

In a recent issue of one of the scientific magazines[2] the following statement appears:

> Fortunately, however, true science is not dogmatic. . . . Instead, it seeks through every possible avenue of information to assemble and coordinate all available facts and to evaluate and interpret them without bias and it fully realizes that opinions can neither alter nor replace facts, regardless of how unexpected they may be.

It is always more interesting to speculate than to ascertain facts; easier to theorize than to prove; and more convenient to accept the conclusions of others, whether right or wrong, than to analyze a problem ourselves and form our own conclusions based on facts.

Definitions of Terms

Before discussing the subject of my paper, it may be well to define clearly certain terms to be used, because the loose way in which they have been used may be responsible partly for the apparent misunderstandings prevailing today, as well as for many inaccurate, erroneous and misleading statements that have appeared in various publications. These definitions are very elementary, as it would take too long to present an understandable technical definition for each term.

Combustion, generally speaking, implies some form of chemical change accompanied by the evolution of both heat and light. Although there are examples of true combustion in the entire absence of oxygen, the term as used in this paper means oxidation. There are two types of combustion, namely: slow combustion which is not accompanied by light, such as the oxidation of iron; and rapid combustion which we know as "fire," due to the presence of flame. We see a flame when the heat produced is great enough to raise the temperature of the products of combustion to incandescence. In reality we do not see actual combustion or burning, but simply its results. The term "fire" includes both combustion and flame, and the results of both.

Apparent Ignition-Temperature of an element or compound, whether solid, liquid or gaseous, is the temperature required to initiate or cause oxidation sufficiently rapid to be self-sustained when the heating or heated element is removed.

Flash Point of a liquid is the temperature at which it gives off vapor sufficient to form an ignitible mixture with the air contained in the vessel used. It does not mean that no evaporation takes place below that temperature but that vapor does not come off freely enough to meet flash-point classification-requirements. This term applies more especially to flammable liquids, although there are certain solids, such as camphor and naphthalene, that slowly evaporate or volatilize at ordinary room temperature and therefore have flash points.

Flash Fire is very rapid combustion; it can take place only (*a*) in highly flammable solids which contain sufficient oxygen for complete or nearly complete combustion, or (*b*) when the particles of a combustible vapor or dust are suspended in a diffused state in the air, close enough to each other to allow propagation of flame through the vapor or dust cloud and still sufficiently separated to leave room for the necessary amount of oxygen for complete combustion. In either case there must be a source of ignition sufficiently high in temperature to meet the apparent ignition-temperature of the material.

Explosive Range refers to definite limitations to the combustibility and rate of burning of flammable vapor or dust mixed with the air. When the particles are so widely separated that those set on fire by the igniting medium will not set fire to others that are nearest, the mixture is called too "lean" for combustion and will not burn. When the particles are so close together that they exclude the oxygen necessary for combustion the mixture is called too "rich," and it will not burn. The concentration, or per cent by volume, between the leanest and the richest mixtures that will burn is called the explosive range. Between the minimum and maximum limits of the explosive range will be found various phases of slow and rapid combustion.

Vapor or *Dust Explosion* results when the products of combustion from a flash fire are sufficiently confined to generate pressure.

Explosion or *Detonation* presupposes a sudden violent change of pressure, characteristically involving the

[1] Manager of the safety and fire protection division, E. I. du Pont de Nemours & Co., Wilmington, Del. In the absence of Mr. Miner, the paper was presented by P. V. Tilden, of the same company. Mr. Miner's discussion was presented later, in written form.

[2] Harold J. Cook, *Scientific American*, August, 1927, p. 114.

TABLE 1—PROPERTIES OF VARIOUS FLAMMABLE LIQUIDS[3]

	Flash Point Deg. Fahr.	Apparent Ignition Temperature Deg. Fahr.	Explosive Range by Volume of Vapor Low	High
Ethyl Ether	—49.0	356	3.0	7.5
Gasoline	— 0.4	536	1.4	6.0
Benzol	—16.6	932	2.7	6.3
Acetone	— 4.0	...	2.0	9.0
Ethyl Alcohol	53.6	815	4.0	13.0
Turpentine	91.4	464	2.0	7.0[a]

[3] From Appendix 1-Underwriters' Laboratories Report on Propagation of Flame in Pipes, and Effectiveness of Arresters, Oct. 1, 1919.
[a] Approximate.

liberation and expansion of a large volume of gas due to high temperature. The change taking place is a progressive one proceeding from one part of the exploding material to the next adjoining part. The term detonation usually is applied to an explosion of very high order, where high velocities are involved.

Pressure Rupture, such as failure of an air receiver, steam boiler or closed receptacle containing liquids, is a rupture resulting from internal pressure exceeding the ultimate strength of the container. The terms explosion and detonation, particularly explosion, are commonly and erroneously used to include pressure ruptures. While the results may be similar, the physical phenomenon of a pressure rupture is entirely different. A true explosion or detonation involves chemical change, while a pressure rupture is merely the failure of the inclosing receptacle because of too great internal pressure.

Compressed air was first used for applying finishing materials about 1890. During the World War, when it was necessary to speed up production so materially, the use of the spray method of applying coating materials extended very rapidly, not only facilitating output but also effecting a substantial saving in manufacturing cost.

With the development of the quick-drying finishes of the pyroxylin type it thus far has been necessary to use the spray method of application to apply the coating quickly and uniformly. It has been estimated recently that about 75 per cent of all the finishing materials used today in industry, for all purposes, are applied by the spray method.

Spray-Painting Hazards Long Recognized

The fire hazards introduced through the application of flammable coating-materials by the spray method have been recognized for many years. Safeguards recommended by the National Fire Protection Association and the National Board of Fire Underwriters have included properly designed and located rooms and non-combustible spray booths or tunnels; adequate ventilation; good housekeeping; proper handling and storage of finishing materials; safeguarding of electrical hazards; elimination of open fires, unprotected flames, sparking or friction hazards; and adequate fire protection. While much has been done toward controlling this fire hazard, much still remains to be done to bring about safe conditions.

Since the introduction of the quick-drying pyroxylin finishes, there has been a tendency on the part of some regulatory bodies to accept existing conditions for the application of oil paints, varnishes and other flammable finishing-materials of the older type and to restrict or prevent the application of the newer quick-drying pyroxylin-type finishes by the spray method unless radical changes are made.

In reality the fire hazard from the spray application of finishing materials is due to the method of application rather than to type of material. A number of serious fires have occurred in furniture factories in the South, due, so far as can be determined, to spraying operations. Widespread publicity has been given to the statement that these very disastrous fires resulted from the use of pyroxylin finishes. This, however, has been denied by the National Board of Fire Underwriters in a recent statement which reads as follows:

> It is claimed that in North Carolina, during a period of 6 months, 11 fires involving pyroxylin finishing materials in furniture factories caused losses totaling over $1,000,000. The statement is approximately correct so far as the number of fires and the amount of loss is concerned, but is in error in reference to pyroxylin finishes. None of these fires involved pyroxylin finishes, but on the other hand did involve varnishes and enamels.

About a year ago a very serious fire occurred in a furniture factory in Grand Rapids, Mich., where pyroxylin finishes were being used, and recently there occurred a very serious fire and explosion in the Briggs Mfg. Co.'s body plant at Detroit, indirectly if not directly due to the use of pyroxylin finishes.

An analysis of these fires, as well as others which have occurred in widely separated territories, involving all types of flammable finishing material, clearly supports the statement that the hazard is largely one of application rather than of the type of coating material.

Flash Points Are Classified

It is an accepted practice to classify volatile flammable liquids as to fire hazard according to their flash points with a closed-cup tester. The classification used by the National Fire Protection Association and the National Board of Fire Underwriters is as follows:

Class 1 *Liquids.*—Those with a flash point below 25 deg. fahr.

Class 2 *Liquids.*—Those with a flash point above Class 1 and below 70 deg. fahr.

Class 3 *Liquids.*—Those with a flash point above that for Class 2 and below 187 deg. fahr.

This places among class 1 liquids, gasoline, naphtha, benzol and acetone. Class 2 liquids embrace alcohol, amyl acetate, toluol, ethyl acetate, methyl acetate and similar liquids. Class 3 liquids include amyl alcohol, turpentine and fuel oil.

Other characteristics, such as ignition point, explosive range, vapor density, volatility and diffusion, should be taken into consideration in the classification of volatile flammable liquids as to fire hazard, or to judge the fire hazard attending the use of volatile flammable liquids or compounds containing them, as will appear from examination of Table 1.

TABLE 2—APPARENT IGNITION TEMPERATURE IN DEG. FAHR. OF VAPORS BY DIFFERENT HOT METALS.[4]

Sample	Copper	Steel	Brass	Aluminum	Zinc
Spirits of Turpentine	285	425	352	440	580
Motor Gasoline	410	530	520	564	No ignition
Turpentine No. 1 Substitute	403	550	...	530	612
Turpentine No. 2 Substitute	395	530	...	528	593
Japan	440	500	...	...	...
Wrought-Iron Japan	398	490	...	...	...
Varnish 164	...	510	...	...	...
Varnish 165	...	515	...	...	...
Kerosene	412	510	452	600	637
55-Deg. Baumé Naphtha	375	520	430	512	585

[4] From a report of the National Association of Steel Furniture Manufacturers on Explosion of Enameling Oven at Yawman & Erbe Mfg. Co., Nov. 6, 1925.

It will be noted that there is no relation between the flash point and the apparent ignition-temperature. For example, gasoline, with a flash point below zero fahr., has an apparent vapor-ignition temperature of 536 deg.; while benzol, with a flash point still lower than gasoline, has an apparent vapor ignition temperature nearly twice that of gasoline, or 932 deg. On the other hand, turpentine, with a flash-point of 91.4 deg., has an apparent-ignition temperature nearly 100 deg. below that of gasoline, or 464 deg., according to the Underwriters' Laboratories tests. One of the best-known pyroxylin finishes approximates ethyl alcohol as to both flash point and apparent vapor-ignition temperature.

Low Flash-Point and High Ignition-Point

We thus find that many thinners or solvents with low flash-points have high apparent vapor-ignition points and vice versa. Furthermore, spraying or atomization accelerates volatilization or causes these liquids to be broken up into a very fine mist, the flash fire and explosion possibilities of which, once ignited, are similar or equal to that of a vapor. Similar treatment and safeguards are therefore needed for all the different types of flammable finishes.

Further evidence of the importance of taking into consideration the properties listed in Table 1 came as the result of an enameling-oven explosion that occurred about a year ago. Following the explosion, ignition-temperature tests were made to obtain the lowest temperature at which there was danger of ignition of vapors from the coated material. The report from which Table 2 is quoted states that the variations in the ignition temperatures of the vapors tested can be explained only by catalytic action.

H. L. Miner

It has been stated that, with the exception of silver and a few other precious metals, copper is one of the best catalysts known. Consequently, care should be taken to see that any copper that may come into contact with flammable gases is protected suitably, if there is a possibility of its becoming heated. Table 2 indicates that turpentine vapors will ignite when brought into contact with steel heated to 425 deg. fahr., or with copper heated to only 285 deg., the latter temperature being somewhat lower than the charring point of paper or wood.

Ventilation Is the Essential Safeguard

Serious as it may appear, the spraying hazard is readily safeguarded by adequate ventilation, namely, that sufficient immediately to diffuse or dilute the spray of vapor or dust below the lower limits of its explosive range, and to remove it while still in the same diluted state. This eliminates any possibility of fire or explosion.

Thus it seems that the solution of the problem is not to classify the material as to its flash point, apparent vapor-ignition temperature or explosive range, but to provide adequate ventilation. This assumes that all other fire hazards, such as unprotected switches, fuses, lights, sparking devices, flames and fire, will be eliminated or suitably safeguarded and that good housekeeping will be maintained.

The next phase of the problem is the condition of the spray booth or tunnel. As the spray from oil-type paints, enamels and varnishes is slow-drying, it collects on the sides and bottom of the booth, on fan and fan casings, and in ducts and stacks, introducing bad housekeeping conditions. The spontaneous-combustion hazard of paint and varnish compounds in contact with rags, waste and other combustible or carbonaceous materials is well established and many fires have resulted from this cause. These coatings or loadings burn rapidly when ignited and are difficult to estinguish.

Quick-drying pyroxylin finishes eliminate the gummy deposit resulting from paint, enamel or varnish spraying, with the attendant spontaneous-combustion hazard. However, the combustible dust or residue is an equally acute hazard. This residue results from the rapid evaporation of the solvent from the minute drops or globules of the spray that do not adhere to the article being coated. With adequate ventilation and properly arranged booths and ducts, where concentrated spraying is carried on, the greater part of the dust or residue is carried out of the building. The residue hazard was pointed out in a pamphlet in 1925[5], as follows:

> **The residue or deposit which may collect in the ducts, spray booth or spray room in which Duco and similar pyroxylin finishes are sprayed is very inflammable and when suspended in the air as a dust cloud in proper proportions introduces the same explosion or flash-fire hazard as sugar, starch, flour, wood-dust, and other inflammable dusts. . . .**
>
> **Duco and thinner, separately or mixed together, can under no conditions be exploded, and the same is true of the residue which remains after the solvent or thinner has evaporated, unless suspended in a dust cloud in the air. . . .**
>
> **Neither Duco nor the thinner, separate or combined, can be ignited while being sprayed from spray-guns operating under normal pressure, in fact during tests it was found possible to extinguish small fires with the spray.**

Dust Explosions Are Possible

One of the most recent interesting experiences indicating the flash-fire or dust-explosion hazard introduced

[5] See Precautions in the Use of Duco, Third Edition, Nov., 1925, p. 4, the E. I. du Pont de Nemours & Co.

by combustible vapors or dusts is described in the following news item[6]:

> Ordinary household sugar, under certain circumstances, acts like gunpowder, five men repairing an elevator learned today. They were welding a cable with an acetylene torch when a 70-lb. sack of pulverized sugar fell from a floor above, landing on the caging of the car and filling it with a cloud of tiny sugar particles, which flared up, ignited by the torch. The five men were taken to Polyclinic Hospital severely burned about the face, arms and body.

The dust or residue that usually results from the spraying of pyroxylin finishes, composed of pyroxylin cotton, gums, resins, colors, pigments, and plasticizers, is very flammable and easy to ignite. The residue from one well-known pyroxylin finish was carefully tested by the Underwriters' Laboratories, Inc. It was found to be stable at temperatures more than 100 deg. fahr. higher than ordinary room-temperature. Samples were tested at from 185 to 194 deg. fahr. for 32 days without any change. At temperatures of 212 deg. and higher, residue has been known to decompose under laboratory conditions, but never in industry. The report[7] states:

> While the conditions under which the laboratory tests were made were more favorable for rapid decomposition than those which might be expected in actual practice, they indicate the importance of not allowing deposits from any pyroxylin finish to collect on steam coils or other heating or heated devices.

This specifically warns against conditions observed in some large plants brought about by failure to provide adequate ventilation. It is to be presumed that the residues from the various pyroxylin finishes are very similar in their characteristics.

In regard to the question of health, it is admitted that benzol should be eliminated from the diluents used in the thinning of flammable finishes whenever possible, but even materials of this character, or compounds containing them, can be applied safely by the spray method with adequate ventilation; for, if the vapors are removed as formed so that they cannot be inhaled, they cannot injure the workmen.

Storage Problems Considered

In the storage, handling and use of flammable finishes, the first problem is the storage of the main supplies. There seems to be some misunderstanding as to whether pyroxylin finishes should be stored in the same manner as paints, varnishes, enamels and other flammable finishes. To clarify this, the following is quoted from the introductory paragraphs of a report[8] which has been adopted tentatively as a standard by the National Fire Protection Association:

(1) Flammable liquids, such as gasoline, lacquers, varnish, turpentine, paints, oils, etc., when stored in sealed original containers present a potential rather than an active hazard. The latter results when the containers are open and when the liquids are transferred or handled by means of open containers or receptacles. This is due to the opportunity afforded the vapors to escape and become ignited by various means. The degree of hazard in such cases depends upon the capacity of the containers and to a certain extent upon the area of the liquid surface exposed

(2) When stored in original sealed containers, that is, "dead storage," the hazard is that due to the possibility of storage becoming involved by fire from without. Under such conditions the hazard, as in the case of open containers, will depend upon the character of the liquid as well as the capacity of the containers. For this reason the storage of large amounts of flammable liquids in containers of large size, or handling or mixing operations involving considerable amounts of such liquids, should be segregated and restricted to specially constructed storage rooms or storage houses as hereinafter described

This report contains specifications for the construction of rooms, cabinets and outside houses for the storage of flammable liquids. Details of construction and arrangement can be obtained from the National Fire Protection Association, the National Board of Fire Underwriters, or through insurance representatives.

Fire May Rupture Closed Receptacles

Frequently, during serious fires, closed receptacles containing liquids, even heavy lubricating oils, have been ruptured because of the development of internal pressure. These ruptures have been referred to erroneously as explosions; they are in reality pressure ruptures. When such a pressure rupture during a fire releases flammable liquids the fire is usually greatly intensified. This possibility should be borne in mind when considering location and protection of main supplies.

Spray booths or tunnels should be of non-combustible construction. Each should be equipped with an exhaust fan or fans capable of moving the air past the working face of the booth or point of operation toward the outlet at a speed of not less than 125 lineal ft. per min., as measured by a vane anemometer. This rate should be maintained approximately uniform over not less than 75 per cent of the working-face area. Fans should be of such size and capacity as to perform the required duty without overspeeding.

The underlying object of ventilation where flammable finishes are sprayed is to dilute the vapors below the lower limits of their explosive ranges to prevent their spread from designated areas and to provide for their immediate removal. Where spray operations are carried on in an open room and not within booths or similar compartments, sufficient air should be exhausted to assure an air change at least every 3 min.

The adequacy of the ventilating system will depend upon the observance of the following fundamental principles:

(1) Provision must be made for admitting to the spray room and booth at least the same amount of air that is being exhausted from it

(2) The fresh-air supply should be distributed in such a manner as to avoid back drafts from exhaust chambers

(3) The windows or doors adjacent to spray booths should be kept closed and air admitted only through designated openings

(4) Spray guns should be operated only within the spray booth and far enough therein so that the spray will not rebound beyond a point where the exhaust is effective

Every large installation presents an individual problem requiring separate and special consideration. Either a competent adviser should be employed or the equipment should be purchased from firms of recognized standing and experience. Any spray booth which permits the visible escape of vapor or dust is in need of special engineering treatment. Reliable operation of the ventilating

[6] See *Philadelphia Inquirer*, June 3, 1927.

[7] See Precautions in the Use of Duco, Third Edition, Nov., 1925, p. 4, the E. I. du Pont de Nemours & Co.

[8] See Report of Committee on Flammable Liquids, National Fire Protective Association, May, 1927.

system will depend upon the maintenance of conditions used as a basis for design. These conditions should be checked frequently.

Daily Cleaning Is Necessary

As already indicated, good housekeeping is of vital importance. Spray booths, spray rooms, ducts, stacks, fans and other equipment should be kept as free from deposits as practicable by cleaning daily, and oftener if necessary. For cleaning purposes, only non-sparking implements should be used. With pyroxylin finishes, all surfaces of booths and ducts where dust accumulates should be thoroughly wet before beginning cleaning operations. Where extensive spraying operations are carried on, probably the best solution of the housekeeping problem is to waterproof and drain the floors so that the ducts, stacks and booths can be flushed with water. Such provisions have been made in several large installations. In many spray-booth installations this is not practicable and there are numerous other ways in which good housekeeping can be facilitated.

Cleaning interiors of spray booths may be aided by applying a heavy coating of plaster of paris or whiting or by covering the walls and roof with a heavy coating of cup grease or vaseline, over which is usually applied heavy manila paper. For cleaning, the paper is stripped off, immediately removed from the building and burned. If paper is not used, the deposit adhering directly to the grease or vaseline is scraped off and disposed of.

In one instance, the interior of the booths was sprayed with a heavy, non-oxidizing oil such as motor oil or tempering oil. In cleaning, the interior is blown down with wet steam while the ventilating system is kept in operation. The steam loosens the deposit from the oiled surface and at the same time dampens it. In several tests on one installation, practically all of the residue was discharged to the outside of the building through the ventilating system.

At times it may be necessary to use flammable solvents for cleaning. When this is done they should be used sparingly and the ventilating system should be kept in operation. If the amount used does not produce a greater quantity of flammable vapor in the spraying chamber than that resulting from the operation of the spray gun, or guns, it may be assumed that the ventilating system will handle it safely.

It is of great importance that the installation be kept free from deposits, regardless of type of flammable finish used. How the good housekeeping conditions are obtained is not so important as it is to obtain them.

Again I wish to emphasize that the dry residue which collects in booths and ducts where pyroxylin finishes are sprayed is highly flammable and when it is ignited the resulting fire spreads rapidly. Employes must not be allowed to enter stacks or ducts for cleaning until the stacks and ducts are completely freed from flammable vapors and are thoroughly wet throughout their entire length.

Ordinary Precautions Must Be Observed

There are other fire precautions that must be observed, such as the use of properly designed and protected electrical equipment; elimination of sparking devices, open fires or flames; and prohibition of smoking. These obvious points have been covered in detail in the various regulations, and they should not be overlooked nor slighted.

The following is quoted from a recent statement[9] published by the National Board of Fire Underwriters:

> Fires in spray booths, regardless of the finishing material employed, as a general rule result from four principal causes:
>
> (1) Fans and motors used for venting booths
> (2) Broken electric lamps and other electrical defects
> (3) Cleaning interior of booths, fans and motors with highly flammable solvents
> (4) Accumulations of deposits or residue in the tubes and vent pipes resulting from neglect to clean them frequently and from poor design
>
> It is a fact that these fires fail to demonstrate any hazard that was not previously known and made the subject of a special safeguard requirement.

Care always must be taken, in treating a problem of this nature, not to allow hysteria or fears to overbalance common sense. Serious fires are occurring every day throughout the Country in the greatest variety of occupancies, most of which result from commonplace causes. Such experiences are more or less expected and usually are accepted without the slightest qualm or disturbance.

It is the unusual fire that immediately arouses regulatory bodies; and their tendency is to enact ordinances, laws or regulations that often are impracticable as well as unnecessarily severe. It behooves the users of the spray method of applying flammable finishes to provide and install necessary safeguards and take precautionary measures to prevent serious fires and the distressing results that so often follow.

THE DISCUSSION

C. C. Ward[10]:—The spray rooms of the Hudson factory are not a fire hazard, as they are cleaned thoroughly every evening. The stacks are washed out, the booths are steamed out and the sprinkler heads are thoroughly wiped so that they can be seen at any time. The booths are coated with a greasy material to keep the pyroxylin finish from sticking to the metal, and it is taken off the next evening. The pipes and steam coils are cleaned off every month, and there is no collection whatever in the stacks.

Earl Seger[11]:—The men who are using the spray guns have a tendency to begin spraying a car before it gets into the booth. How do other factories overcome this?

P. V. Tilden:—That is a question of supervision. No spraying should be done outside the booths or tunnels provided for that purpose. Otherwise the spray enters the room and is not immediately diluted and carried away as it should be.

H. S. McClellan[12]:—We have a new spraying room under construction and we are trying to provide every known safeguard and are looking for information. We are installing metal booths, and have paid a great deal of attention to the ventilating and cleaning problem. Should the stacks and the spray booths be grounded to prevent any attack from lightning or the accumulation of a static charge in the metal work?

Mr. Tilden:—Yes, the paint-spraying and spray-booth regulations of the National Board of Fire Underwriters call for the installation of booths, duct work and ven-

[9] See *Safeguarding America against Fire*, May, 1927, p. 4.

[10] Fire marshal, Hudson Motor Car Co., Detroit.

[11] M.S.A.E.—Superintendent of maintenance, body plant, Hudson Motor Car Co., Detroit.

[12] M.S.A.E.—General superintendent, Chrysler Corporation, Detroit.

tilating equipment in accordance with the blower regulations, which require the thorough grounding of all duct work, including motors, fans, booths and ducts.

MR. MCCLELLAN:—I also understand that the board recommends sprinkler equipment. Is that for stacks and spray booths?

SPRINKLERS ARE USEFUL

MR. TILDEN:—Sprinklers are required by the regulations, excepting where the vent tubes and stacks are very short.

CHAIRMAN JOHN YOUNGER[12]:—Does a water sprinkler really put out a fire of this sort; is water effective on a lacquer fire?

MR. TILDEN:—Automatic sprinklers will control fires in pyroxylin finishes. This is due to the blanketing effect of the water discharged, which not only extinguishes the fire, but also provides a curtain of water around the burning material, and thus prevents the spread of the fire. When, however, a heavy stream of water is discharged into a tank or open receptacle containing burning liquid, the water bores underneath the surface and has very little effect. On fires in the pyroxylin deposit, sprinklers are very effective.

MR. SEGER:—At the Hudson plant we have had one or two very small fires of unknown origin and the sprinkler has put them out very quickly. There was damage amounting to less than $5 in one case. After that we installed more sprinklers. Mr. Ward has charge of the sprinkler system and I doubt if a space of 5 ft. can be found that is not well protected by a sprinkler.

SAFETY OF INSTALLATIONS DEMONSTRATED

ELWOOD G. RICHARDSON[14]:—Vapor samples from exhaust ducts of spray booths, that were regarded as good factory installations, have been drawn repeatedly during operation at full capacity with lacquer. When introduced into an explosion bomb and sparked, the samples could not be made to explode. Examination showed that the vapor present was only one one-hundredth of the amount necessary to form an explosive mixture.

The primary hazard is unquestionably the loosely deposited dust that can be ignited instantly by a spark. Accumulations of dust must be prevented by frequent and thorough cleaning.

Probably there is more hazard now in the small refinishing shops than in the factories, where conditions are well in hand in most cases.

H. L. MINER:—At the present time there are from 6000 to 7000 refinishing shops in the United States using Duco, and probably several thousand more using other quick-drying finishes, largely of the pyroxylyn type. The majority of these shops have been operating for two years or more. Some of them have good ventilation, but most of them have no ventilation at all except that obtained through doors and windows. In some shops the spray operations have been carried on, we find, in close proximity to stoves, furnaces, and gas heaters.

In spite of such conditions, that are recognized to be very undesirable, so far there has not occurred, to my knowledge, one fire resulting from the spraying operations, either directly or indirectly. If the refinishing shop hazard were at all severe or pronounced, it would have manifested itself prior to this.

The problem of adequately guarding spraying operations in the shops is at present receiving active consideration by the National Board of Fire Underwriters, and its model ordinance, "Suggested Ordinance Regulating the Handling, Storage and Sale of Flammable Liquids and the Products Thereof," applies only where more than one gallon is sprayed during a working day.

It should be thoroughly understood, however, that the du Pont company and other reputable manufacturers heartily endorse the recommendations of both the National Board of Fire Underwriters and the National Fire Protection Association. The fire record is, to some degree, a measure of the fire hazard involved. While the fire record of refinishing shops has been excellent, the inherent fire-hazard introduced through the spraying of flammable finishes is recognized, and it is hoped that all refinishing shops will adopt the precautions set forth in the publications of these associations, at least in all essential details, paying particular attention to adequate ventilation and good housekeeping.

CATALYTIC ACTION IS CONFIRMED

A. C. F. LUKE[15]:—Some fire experience I have had with nitro-cellulose dopes on airplanes is worth mentioning in connection with the use of electric appliances. For no accountable reason, a flame seemed to play suddenly across the wing on one side of a plane that was being prepared for the water. The flame seemed to originate from a man who was soldering a piece of copper wire with an ordinary soldering iron. We made several attempts to reproduce the fire experimentally. We blamed the dope, which had acquired a bad name for fire during the war, but could not confirm our suspicion.

A few days later I saw a man who was soldering a piece of copper wire suddenly take off his cap to stop a flame that was traveling along the wire. That incident reopened the investigation, which is not yet completed. I believe that the mystery has been explained in this paper, which shows that copper at a temperature of 285 deg. fahr. is dangerous to have near any highly inflammable vapors.

CHAIRMAN YOUNGER:—I wonder if the copper-asbestos gasket in the cylinder-head plays a more important part than we realize. This influence of copper is new information to me.

[12] M.S.A.E.—President and editor, *Automotive Abstracts*, Columbus, Ohio.

[14] M.S.A.E.—Chief chemist, Berry Bros., Inc., Detroit.

[15] Flying officer, Royal Canadian Air Force.

Vol. XXI December, 1927 No. 6

Oversea Navigation

By LIEUT. A. F. HEGENBERGER, U. S. A.,[1] AND BRADLEY JONES[1]

AERONAUTIC MEETING PAPER *Illustrated with* PHOTOGRAPHS AND CHARTS

THE amount and kind of aviation equipment and the navigation methods essential to a successful transoceanic flight vary considerably with the route and with the conditions prevailing during the time of the flight. Over some routes, as from Newfoundland to Ireland, a flight may be so timed as to have tail winds over almost the entire distance. Col. Charles A. Lindbergh demonstrated that, under such conditions, wind-drift measurements can be neglected and the course can be flown successfully by the compass alone. Great accuracy in reaching the destination in this way is exceptional, however, as errors due to fluctuations in the wind and in holding the proper heading rarely cancel out.

On routes such as that from San Francisco to Hawaii, wind conditions are never favorable throughout the entire distance. The Army flight to Hawaii encountered a 30-m.p.h. cross-wind, producing a 17-deg. southerly drift, during the early part of the trip. As all errors could not aggregate, with safety, more than 3¾ deg., the importance of accurately measuring and correcting for this drift is evident. When avigating a route requiring such great accuracy, dead-reckoning alone is uncertain of success because of the possibility that errors will be cumulative. Due to a fortunate combination of circumstances, some flights may succeed with scanty equipment and meager preparation, but, to assure success under all conditions, complete equipment for dead-reckoning and for astronomical and radio avigation should be available.

Avigation equipment and methods vary with each individual flight.

Flights may succeed with minimum equipment and preparation, but this is not recommended for safety.

The brain-work of avigation never can become subconscious, so fatigue affects the efficiency.

The avigation of a flight should start well before the take-off.

Climate affects the choice of route; weather influences the time of take-off.

Dead-reckoning and radio and astronomic avigation are all desirable.

DUTIES OF THE AVIGATOR ARE EXACTING

Not only should the avigator have the proper equipment, but it is also essential that he should have thorough training in its use and a complete understanding of its limitations. The operation of present avigation instruments and the reduction of the observations are by far the most difficult functions that are performed in the air. Because of the mental gymnastics involved, these operations never become instinctive, as does piloting. Fatigue, due largely to the noise and vibration in the airplane, reduces one's mental efficiency tremendously during a long flight. Under such conditions, the most simple mental activity becomes most difficult, and serious errors in results and decisions may be made. Because the duties of a pilot become mostly instinctive or subconscious with experience, fatigue has a similar effect on the pilot's efficiency only to a very slight degree. The avigator's duties, however, require constant mental alertness and never can become automatic. It is under conditions of fatigue that the avigator's background of experience is a vital necessity.

An oversea avigator has a more difficult task than an ocean navigator. The air navigator must work in cramped space instead of a commodious, comfortable chart-room. He must compute positions almost instantly instead of in the leisurely manner permitted the mariner. Once started on an air voyage, he must continue, not being able to slacken speed or to heave-to as may his colleague on the sea. On a steamer, magnetic material can be kept at a distance from the compass, but on an airplane the compass is liable to large deviations and to erratic changes in deviation. Probably the greatest handicap to the avigator is that air currents are variable and unknown.

MUCH PRELIMINARY WORK IS POSSIBLE

The navigation of an aircraft should properly start many months before the actual flight. It has been stated that, before the ZR-3 started across the Atlantic, 600 theoretical flights were made over weather maps of the North Atlantic[2]. The Army Hawaiian flight was actually started in 1920 and flown many times theoretically before the airplane actually left the ground last June. This is important, for climatology decides the choice of general route, while meteorology decides when this route may be flown and where deviations should be made from it.

On the Army world cruise, a climatology study showed that the Aleutian Islands route from the United States to Japan might be flown in the spring, and meteorology dictated the exact days and altitudes to fly. The same climatology study showed that in the fall, the time William S. Brock and Edward F. Schlee reached Japan, the chances of reaching the United States via the Aleutians were slim indeed.

In laying out his course the aviator has an advantage over the mariner, as the great circle in the air is unrestricted, while barriers of land often prevent the sea-vessel from following the true great-circle. Going from New York to England or to France, aircraft can fly directly over Newfoundland, while steamers must travel far south of the great circle to avoid this barrier.

The air navigator's decision as to course must be influenced by the consideration of safety in case of a forced

[1] Materiel division, Army Air Corps, Wright Field, Dayton, Ohio.

[2] See Zepplin, the Story of a Great Achievement, by Harry Vissering.

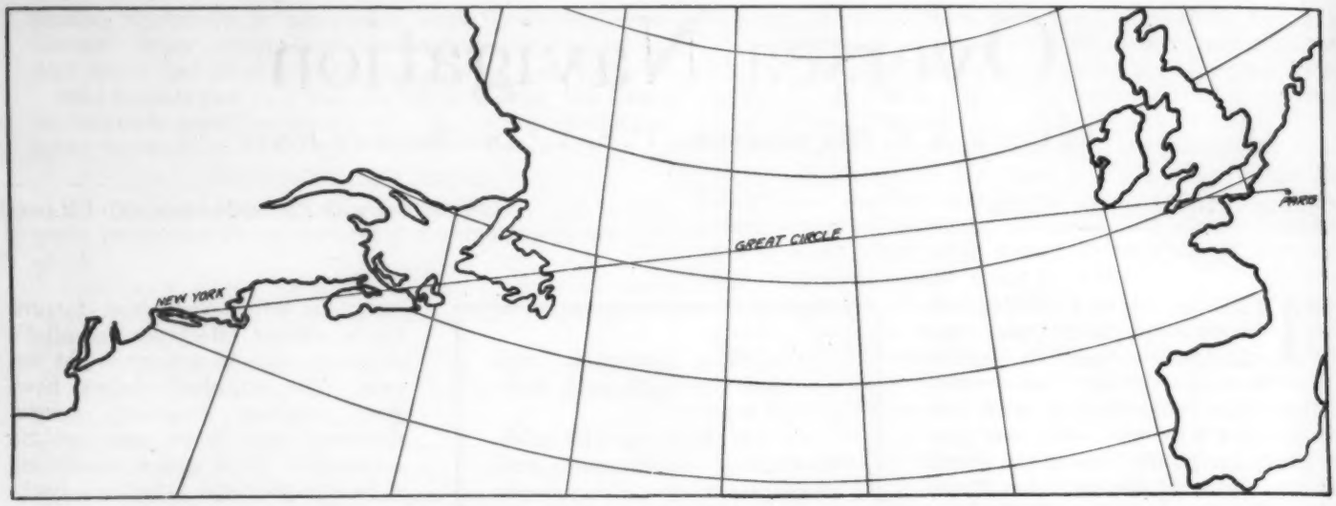


FIG. 1—GREAT-CIRCLE CHART OF THE NEW YORK CITY-TO-PARIS ROUTE

This Is a Spherical Projection, in Which the Great Circle through New York City and Paris Appears as a Straight Line, Showing the Land Areas over Which a Great-Circle Flight Will Pass

landing. The great-circle route from New York City to Paris is 3619 miles long. The distance over open water from Newfoundland to Ireland is 1900 miles, but in this region there are only a few vagrant travelers to come to the aid of aviators in case of mishap. The steamship lane, if followed from New York City to Paris, involves flying 3835 miles, almost entirely over water. Along this route, however, the many ocean liners make the chances of rescue of unfortunate aviators immeasurably better. Figs. 1 and 2 make easy a comparison of the two routes.

Before any long flight is undertaken the weather conditions should be studied, as the information on the synoptic charts may indicate deviating from the great circle. It is understood that Colonel Lindbergh went south of the great-circle course in the earlier part of his flight to obtain more favorable weather. The ZR-3, shortly after leaving the Azores, received warning of an intense low-pressure area centering near the Bermudas. Instead of continuing westward, to bring the craft directly into the storm sector, the navigator headed north and then circled westward over Newfoundland, thus both escaping the gale and picking up a tail wind of 65 m.p.h.

THE METEOROLOGIST'S HELP IS IMPORTANT

In case some latitude is permitted in the time of starting a flight, the advice of the meteorologist as to the proper time of take-off is vital. Too little recognition has been given to the contribution of the meteorologist to the success of transoceanic flights. It is desired to acknowledge now the cooperation and assistance of T. R. Reed, of the San Francisco office of the Weather Bureau, in connection with the Army's Hawaiian flight.

By the position of the isobars, it is possible to estimate roughly both the speed and direction of the wind and thus to make approximate correction for drift. In March, 1924, an Army airplane flew from New York City to Dayton, Ohio, over a double layer of clouds that effec-

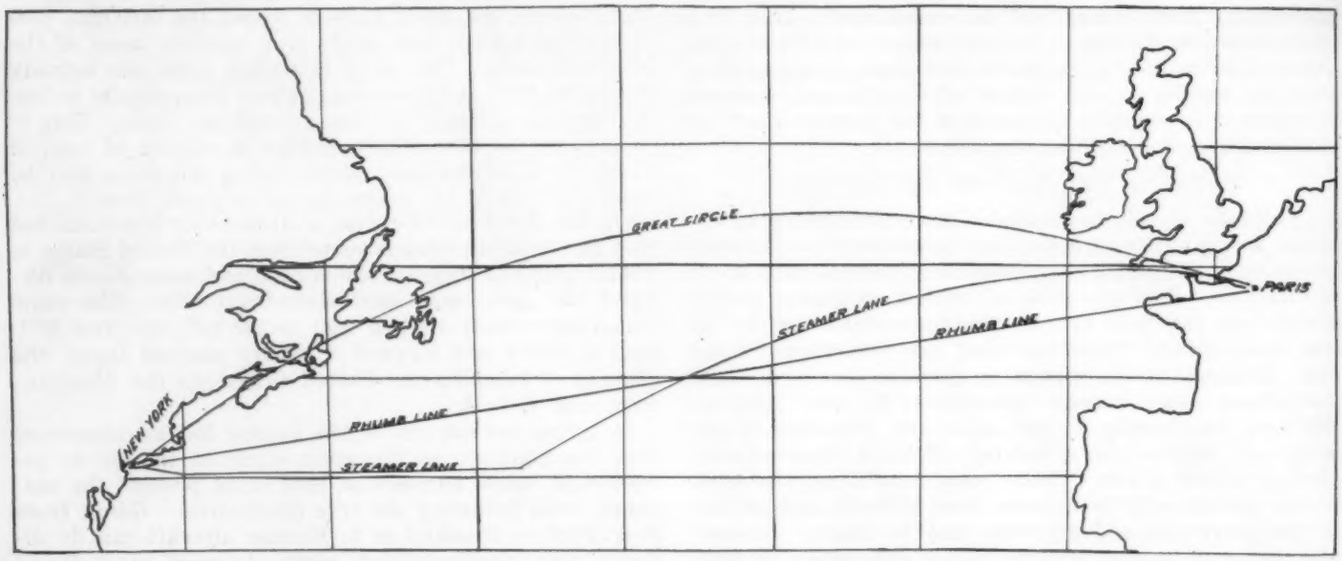


FIG. 2—MERCATOR CHART OF THE NEW YORK CITY-TO-PARIS ROUTE

On the Mercator Chart the Great Circle Is Projected as a Curve. The Steamer Lane Is Due East for About One-Third of the Distance, then Follows the Great Circle from that Point. The Difference Between the Great-Circle Route and the Steamer Route Is Evident

tively prevented drift measurements. A study of the weather map enabled the avigator to guess at the probable wind changes en route, so that, in spite of a 50-m.p.h. gale, the aviators were only 12 miles north of their course on reaching their journey's end.

The methods of avigation may be divided into three classes: dead reckoning, astronomical avigation, and avigation by the aid of radio. At best, the task of an avigator is difficult, so every source of information as to his position should be available to him.

The term "dead-reckoning" involves following a compass course corrected for the compass errors and for the effect of wind drift. Flying by dead-reckoning is contingent on an accurate, reliable compass and proper drift knowledge. Unless both of these are available, the chances of reaching the destination are slim indeed.

On the Army Hawaiian flight, four compasses were carried: a master compass and three steering-compasses.

Available Methods for Measuring Drift

For drift measurements, several methods were available. Two kinds of bombs were carried on the airplane, one giving off smoke for daytime use, the other giving a bright light for night use. These were dropped from the plane to float on the water, and sights were taken after they had been left a couple of miles astern. On the Hawaiian flight, due to the execrable conditions of weather and sea, the smoke bombs were far from satisfactory. The navigator therefore utilized the foam-flecks of a broken wave, which were sighted directly below the airplane with the conventional wire-vane drift-sight.

For day use, bright yellow lines were painted on the horizontal stabilizer, as shown in Fig. 3, radiating from a point in the rear cockpit where the navigator would place his eye. At night, when the painted lines were invisible, a telescope drift-sight was available.

When the sun is abeam of the fliers, a position line is

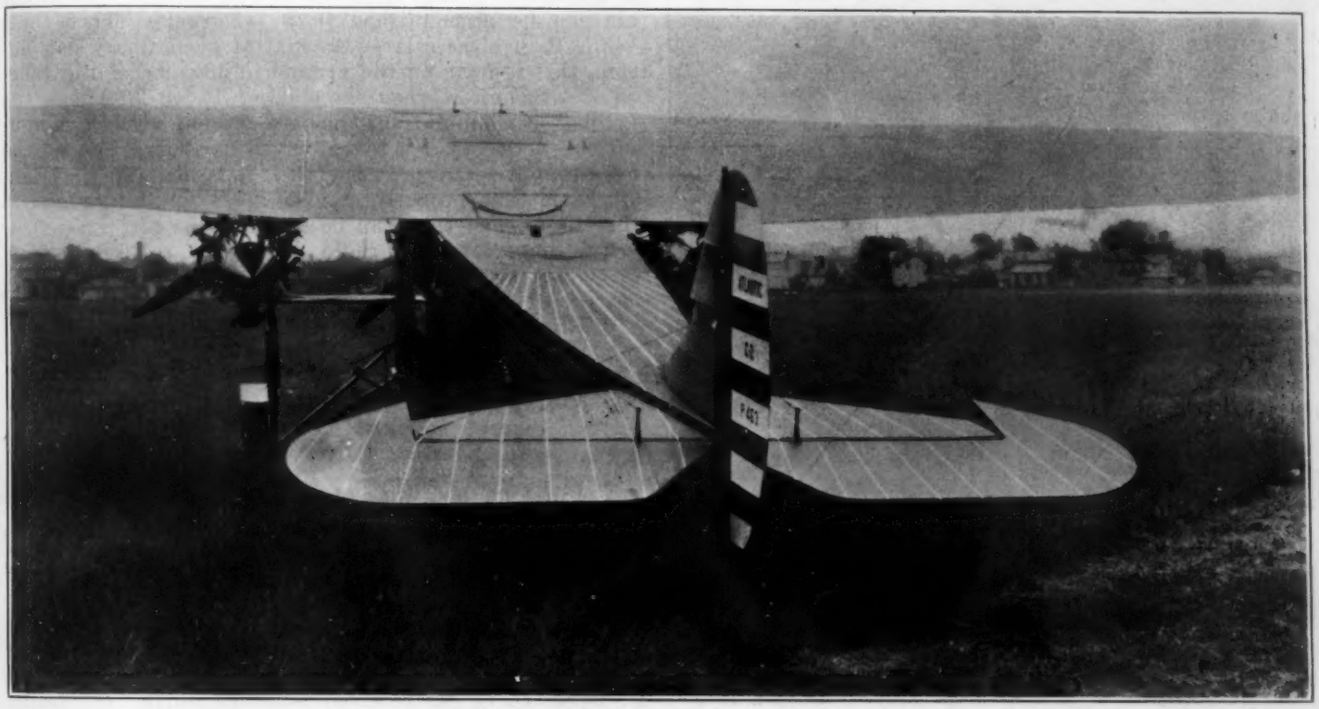


Fig. 3—Rear View of the Army Hawaiian-Flight Airplane
Yellow Lines Were Painted on the Rear Horizontal Surfaces of the Plane, Radiating from a Point in the Cockpit. These Were Used as a Drift Indicator

The master compass was an aperiodic compass with a large bowl. This was mounted on a non-magnetic tripod in the navigator's cockpit. For steering, there were an induction compass and two magnetic-needle compasses.

The magnetic compass has been known and used for centuries, but the type of magnetic compass known as the induction compass is comparatively new. During the 5 years since the Army initiated development of this compass, the instrument has shown great possibilities. On the Hawaiian hop, mechanical failures put it out of commission after a brief period. The two magnetic-needle steering-compasses were of a new type developed by the Army Air Corps and now undergoing experimental test. The card is very legible and remarkably steady.

Great care was taken in swinging these compasses before the take-off. Since the airplane structure is liable to become magnetised in flight, a pelorus was mounted so that checks on the compass could be made in flight from the sun's azimuth.

obtainable which parallels the course. If the sextant shot is at all reliable, this is a most valuable means of obtaining drift correction, for it summates all the errors in the course flown up to the time of taking the sight. When the true horizon can be used, astronomic navigation of aircraft approaches the reliability and accuracy of that of a marine vessel. Unfortunately, too often the sea horizon cannot be used on transoceanic flights, and the artificial horizon in aircraft is far from perfect. The tossing and pitching of an airplane, while serious, are minor troubles compared with the changes in speed caused by the pitching. A small change in angle of attack, if it occurs suddenly, will throw off the reading of an artificial horizon by a large amount.

A sextant for use on an airplane must be light and compact. It is often necessary to hold the sextant in the slipstream, and the user must grip it tightly to prevent the instrument from being torn from his grasp.

Fig. 4 shows an avigator using a sextant. The arti-

ficial-horizon attachment is usually in the form of a spirit level. Even under the most favorable conditions the bubble is constantly dancing about. With the true, or sea, horizon the observer is measuring the angular distance between two fixed points, but with an artificial horizon the attempt is made to measure the angular distance between one fixed and one moving point.

Altitude Helps in Locating Objective

The range of visibility from an airplane is much greater than that from the deck of a vessel, so an observer at an altitude of a few thousand feet can discern objects that are invisible from sea-level. As this permits of greater latitude in the errors of locating a position

Fig. 4—Taking Sextant Shots from an Airplane

The Avigator Is Sighting a Sextant Grasped in His Hands. A Spirit-Level Attachment Serves for an Artificial Horizon If the Sea Horizon Is Not Visible

from aloft, the bubble sextant, although far from perfect, is a valuable instrument for avigation.

Sir Arthur W. Brown, the first non-stop transatlantic avigator, stated that, on account of the general obscurity during most of his flight, he considered it fortunate that he carried his bubble sextant, as he seldom caught sight of a clearly defined horizon. On the Army flight to Hawaii, the sea horizon was visible for only the first 1½ hr., even when flying close to the water. All observations were made successfully with a bubble quadrant.

A bubble is a very poor substitute for the natural horizon. It must be sensitive enough to read within 1 deg., and can be damped only slightly without becoming too sluggish. The vibrations and oscillations of the airplane, coupled with the tremors of the hand, tend to keep the bubble in constant motion. Considerable concentration and tension are required to obtain satisfactory readings.

After the altitude of a celestial body is measured by means of the sextant, certain computations must be made before the line of position can be plotted on the chart. The most commonly used method of reducing observations at sea involves some 11 operations, including the extracting of values from tables. This and other methods used at sea are unsatisfactory for use in the air, as the probability of making errors is great and the time required is too long.

Observation Calculations Are Pre-Computed

The Army Air Corps has worked out a method of precomputation so that the reduction of observations in the air can be accomplished in a remarkably short time. While it involves a large amount of preliminary calculation, this is done on the ground in advance of the takeoff. Although it requires making 15 or 20 times the number of computations that are actually used, a computation on the ground takes only a small fraction of the time that it requires in the air. It is believed that considerable time properly may be spent on the ground if thereby a short time can be saved in the air.

The importance of radio as an aid to avigation is growing. Radio has been used in three different ways on transoceanic flights:

(1) By taking bearings on transmitting stations by means of goniometer loops on the aircraft

(2) By transmitting signals for boats to use in taking bearings that are radioed back to the aircraft

(3) The radio beacon

The first method was used by the NC boats with little success. A modification of this, known as the homing method, using fixed loops and pointing the airplane toward the transmitter, was used by Major Ramon Franco. The second method was used successfully by Commander John Rodgers, U. S. N., as he passed each ship on the course, until he reached the Aroostook. The ZR-3 also used this method, and Commander Richard E. Byrd, U. S. N., received bearings during the latter part of his flight. The third method, the radio beacon, was operated by the Army for the benefit of the contestants for the Dole prize and was used successfully by Art. C. Goebel, the winner. Due to failure of reception, the radio beacon was of little help to the Army Hawaiian flight.

To assure the success of transoceanic flights under all conditions, full use should be made of dead-reckoning and of astronomic and radio avigation. Until these methods reach a more perfect stage of development, mechanical troubles and extraneous conditions may cause failures. As steamers equipped with gyroscopic compasses still have frequent recourse to the magnetic compass, so airplanes should not place sole reliance on any one method to the exclusion of the others.

Today's Motorcoach Legislation

By Robert H. Newcomb[1]

Transportation Meeting Paper

ABOUT a year ago the Interstate Commerce Commission gave hearings in regard to the condition of the laws governing highway transportation. To those who heard the testimony presented at these hearings, the title of this paper might appear to be a misnomer. Judging from the variety of opinions and the complexity of desires, there seems to be no motorcoach legislation today.

Quite the reverse is true. Forty-eight separate and distinct jurisdictions have nearly 48 separate and distinct sets of regulations. If there is any State without specific regulatory statutes, the courts can always be called upon to interpret the law covering conditions within that State. It is only when the highway vehicle crosses a State line that the confusion of jurisdiction in the absence of congressional legislation makes evident the necessity for coordinated law.

The various phases of the problem of carrying passengers are sufficient for this discussion. An investigation of the carriage of freight on the highway piles up complications at such a rapid rate that he is brave indeed who attempts to unravel the snarl. It is well to remember that whether any given operation makes the operator a common carrier of either passengers or freight is a matter of fact and not of law. It is the transaction itself and not the movement of any vehicle which constitutes common-carrier service within the meaning of the law. To make the distinction even more definite, let me say that it is futile for a legislative body to declare all persons engaged in the transportation of persons or property for hire by motor-vehicle to be common carriers.

Intrastate motorcoach operation is controlled by the laws of the various States, which generally protect from competition operators that have been granted certificates for certain routes. The tendency is to give preference to existing steam and electric railways against competing operators.

There is no regulatory law for interstate operation, and court decisions limit the power of the States to police duties for safety and for the conservation of the highways, with no regulation of competition.

Interstate motorcoach lines cannot carry intrastate passengers without complying with all the legal requirements of the State in which they are carried.

The Laws in Southern New England

In New England, at least three States have enacted laws placing common carriers of passengers on the highway between fixed and regular termini under the jurisdiction of the several State public-utilities departments. I shall discuss these statutes somewhat in detail to illustrate the type of complication the motorcoach operator has encountered during recent years.

When the carriage of passengers by motor-vehicle first came into prominence about 10 years ago, the only regulatory law in New England was that which applied to the use of carriages for hire, such as city hacks for public service and taxicabs. The so-called jitney flourished for awhile in New England and its only effect on legislation was a broadening of town and city ordinances to cover its activity. When the jitney was succeeded by the motorcoach, about three years ago, the laws in New England allowed any operator to go anywhere, just as the owner of a private passenger-car can avail himself of the highway.

The first statute enacted in Massachusetts gave to the cities and towns the right to issue licenses, but only after the cities and towns had accepted the privilege and had adopted licensing ordinances. The act further provided that, after these local licenses were secured, the holders of the licenses might go to the public-utilities department and apply for a certificate of convenience and necessity, which would validate the entire operation within the State. But the statute further stated that where the operation was interstate its provisions did not apply except insofar as the interstate operator attempted to do an intrastate business. This procedure worked well except that, where local jealousies or disagreements arose, it was possible for one city or town on a given route to refuse to grant a license, thereby depriving other cities and towns on the same route of the service they apparently desired.

This difficulty resulted in the enactment by the Massachusetts legislature of a law, now in existence, which provides that, if a route covers 20 miles and the operator holds licenses in the terminal cities and all but one of the intervening cities, then the public-utilities authorities shall consider the conditions for local licenses satisfied. The same principle governs where there are more than 10 cities or towns intervening between the termini and all but one or two have granted legal authority. Some other conditions safeguard the interests of the nonlicensing town, but this is essentially correct as a broad statement of the situation.

Connecticut went somewhat farther than Massachusetts in its original statute. There the public-utilities commission was given original jurisdiction to issue certificates of convenience and necessity without reference to local licenses; and such certificates, once issued, were protected as sacredly as street-railway franchises. Rhode Island adopted a statute very similar to that of Connecticut.

A chapter could be written on the interesting experiences resulting from the Massachusetts statutes, making each city and town a public-utilities department unto itself. It is obvious that the work of establishing a motor-

[1] Attorney at law, Boston; formerly assistant to vice-president, New York, New Haven & Hartford Railroad.

coach line is tremendously increased under this system; but it should be equally obvious that the individual communities have the greatest interest in the use to which their streets shall be put, and there is a great deal to be said in favor of legislation such as that in force in Massachusetts.

Other conditions precedent to highway operation are generally in force. These include the registration and licensing of motorcoaches and drivers, the regulation of speed, provisions for bonding and insurance to protect the rider in case of accident, and the general exercise of the police powers of the State, over those who use its highways, for the general safety of all highway users.

Interstate and Intrastate Distinction Drawn

For a time it was maintained that each of the several States could exercise practically the same control over motorcoaches that operated across its State lines as it could over those operating exclusively within the individual State. This effort to regulate all carriers was continued actively until 1925, when a decision of the United States Supreme Court explained the distinction between intrastate and interstate commerce in their relations to State authority.

It is not possible to outline in detail the law in all the 48 States. Generally speaking, the condition in the three New England States mentioned is typical of the Country, but there are other regulations, concerning safety devices, size and weight of the coaches, and the like, which vary according to the judgment of the authorities in the several jurisdictions. In any State, the authority of that State over motorcoaches operating entirely within its boundaries is absolute, if exercised within reason.

Today's motorcoach legislation, therefore, in its most interesting phase, is no legislation. Instead we rely upon the interpretation of decisions handed down by the United States courts, based upon that section of the Constitution which provides that Congress, among other things, shall have power to regulate commerce between the States.

To trace the development of this side of the law, we must go back to 1913, when, in the Minnesota Rate Case, 230 U. S. 352, this language was used in discussing the relations between the States and the National Government in the regulation of interstate commerce:

> As to those subjects which require a general system or uniformity of regulation, the power of Congress is exclusive. . . . (In) other matters admitting of diversity of treatment according to the special requirements of local conditions, the States may act within their respective jurisdictions until Congress sees fit to act.

The Court therefore said, what is too obvious to need further comment, that when Congress does act "the exercise of its authority over-rides all conflicting State legislation."

States Cannot Control Interstate Commerce

On the theory enunciated in the Minnesota case, that in matters admitting of diversity of treatment according to local conditions the State might act, the several States undertook such steps as would protect their highways and their citizens. The first of the interpreting decisions clearing up the cloudy situation as to the extent of the legality of State jurisdiction was in a case that arose in the State of Washington and was decided in 1925. The case was that of Buck versus Kuykendall, 267 U. S. 307. It arose under the Washington law, and had to do with a carrier engaged exclusively in interstate business being denied a certificate of convenience and necessity, the public-utilities department taking the ground that the territory involved was adequately served. It was contended that the use of the highways of any State for any purpose was not a right but a privilege and could be regulated by the State in the absence of congressional legislation.

However, the United States Supreme Court pointed out that the State can go only so far as to adopt regulations to promote safety and the conservation of the uses of its highways without imposing an unreasonable burden on interstate commerce. The court said the purpose of the Washington State law was to prohibit competition, not to regulate with a view to safety. The law therefore became a regulation of interstate commerce, not a regulation of the use of the State highways, and its effect was not merely a reasonable burden but actually an obstruction to interstate commerce and as such was forbidden by the commerce clause of the Constitution.

Other decisions, at least a dozen of which could be cited, have followed along the line of that in the case of Buck versus Kuykendall. One decided on the same day, and reported in the same volume, known as Bush Company versus Maloy, applies the same reasoning to the handling of freight on the highway.

The Supreme Court of Rhode Island has fallen in line and held that a certificate cannot be denied a person about to engage in interstate commerce on the ground that the public is being adequately served and that public convenience and necessity do not require the contemplated service.

Interstate Competition Is Wide Open

It having been clearly established that a State may not refuse a certificate of convenience and necessity to anyone engaging in interstate commerce, the field is reasonably well open to anyone who cares to enter it in such congested territory as New England, where large communities lie within easy motoring distance of one another but in separate States.

One other interesting feature was developed by the courts in defining this line of separation between the authority of the several States and of Congress in a case decided in 1925, known as the Newport Electric Corporation versus Oakley, 129 Atl. 613. This case involved a law authorizing the State Public Utilities Commission to specify the route which may be used in interstate commerce, the type of service to be rendered and the question as to whether the service is reasonably exercised for safety and order and for the conservation of the highways. The law was held not to be contrary to the commerce clause of the Constitution, as unnecessary regulations were not placed upon interstate commerce.

On May 16, 1927, the Supreme Court of Massachusetts was upheld in its decision that such a law was an exercise of a reasonable police regulation. A Massachusetts statute provides that operation by a nonresident is equivalent to appointing the Registrar of Motor Vehicles to be the attorney of such nonresident for purposes of the service of legal process in any action growing out of an accident within the State.

In certain sections of the Country, the problem of State regulation has been complicated by the use of roads constructed with Federal aid. The United States Supreme Court has held that Federal-aid legislation is chiefly significant in making clear the purpose of Congress that State highways shall be open to interstate commerce and shall be free from tolls of all kinds. But even such an interpretation placed upon the Federal-aid

acts has not been held to deprive the State of the reasonable exercise of its police power. Registration and licensing of motorcoaches and operators apparently is a proper exercise of State authority, even where interstate commerce is involved, so long as the charges are reasonable and are fixed according to some uniform, fair and practical standard.

Liability Insurance Control Is Not Established

One other phase of the local situation which is still somewhat in doubt deals with the authority of States to force carriers to provide liability insurance or indemnity bonds. The earlier decisions held these requirements to be reasonable, under the police power, and not to be an undue interference with interstate commerce. More recent decisions tend in the other direction. For example, in 1925 the United States District Court, in the case of the Red Ball Transit Co. versus Marshall, held that requiring a company to file a liability-insurance policy or bond, as a condition precedent to issuing a certificate of convenience and necessity, was unconstitutional insofar as it applied to interstate traffic.

In 266 U. S. 570, decided in 1926, the Supreme Court discussed the same condition as applied to motor-truck operation and held such a requirement to be improper under the commerce clause. The carrier involved was a private carrier, but that fact seems not to be significant.

Through all this controversy and changing interpretation of the law, it is an outstanding fact that a carrier engaged in interstate commerce cannot engage also in intrastate commerce unless he is able to comply with the requirements of the State for the latter.

Until Congress sees fit to act for the regulation of interstate commerce over the highway, we are likely to see every promising interstate route of reasonable length occupied by as many carriers as can convince themselves that they may be successful ultimately. There they are subject only to such regulation as is proper under the police power of the several State governments.

Intrastate Certificates Are Good Protection

On the other hand, where highway carriers desire to do a purely intrastate business, the certificates of convenience and necessity that have been issued to any carriers able and willing to comply with the details of the State law seem to protect them from competition in any given territory, as a certificate of convenience and necessity issued for purely intrastate business seems certain to be honored by the public-utilities department granting the certificate.

The local situation is reasonably well cleared up, but public-utility commissions have a feeling that the policy of the States requires existing common carriers, steam railroads and street railways to receive protection from unreasonable competition. For example, the Supreme Court of Appeals of West Virginia, according to newspaper reports, has supported an order of a lower court directing the State Road Commission to authorize motorcoach operation by subsidiaries of the Baltimore & Ohio Railroad and an electric railway. The commission had refused to authorize operations by the railways and had granted certificates for these routes to independent operators. The court holds, inasmuch as the public policy of the State requires the protection of public utilities from unreasonable competition, that when an existing carrier is one of several applicants for motorcoach permits between points already served by it, the State Road Commission should give preference to the existing carrier over other applicants. This preference, it holds further, should be given generally, regardless of priority of other applicants.

Motorcoach legislation is fairly well crystallized for activities wholly within a given State, but no motorcoach legislation today controls interstate business.

Making Labor Valuable

FOR countless centuries before the industrial revolution, in different lands and climates and among different races of men, the most common and, on the whole, the cheapest offering in the public market was labor. Human energy was plentiful but the knowledge of how to use it was scanty. The energy flowed freely enough, but the tools for converting it into practical results were crude and limited. Since the development and general use of power machinery, the value of human labor has increased. No period of increase has been more marked than that of the last quarter of a century in the United States.

The Commerce Year Book for 1926 records the increased productivity per worker during the period from 1899 to 1925 to be 45 per cent in agriculture, 99 per cent in mining, and 48 per cent in manufacturing and railroad transportation. Discussing the major factors in this advance in industrial efficiency, the *Monthly Labor Review* touches on the contribution made by education, by the increased use of capital, improved machinery and power, mass production and the elimination of waste.

In manufacturing industries each wage earner, on the average, is aided by prime movers of a capacity of 4.3 hp., about double the amount in use in 1899. The railroad locomotive has doubled in capacity since 1900, but it is still operated by the same number of men.

Thus, by the education of the worker, by the study of the several tasks to be performed and the fitness of the worker for his task, by the development of new commodities and, therefore, the discovery of new uses for human labor, and by the disposition of mechanical power as an aid subordinate to labor power, the results flowing from labor have been vastly increased. Labor has been made more valuable and, in response to this increased value, the standard of living has materially increased. In America, where the diffusion of education and the use and disposition of mechanical power are widespread, labor enjoys its highest values and the standard of living is highest.

This achievement has been brought about by the cooperation and unstinting effort of thousands of men. But notable in the contribution are the pioneers of invention, industrial organization and education. It is the work of individualists of high imaginative genius operating in an atmosphere of free institutions. These results are not the gift of bureaucracies or institutions for the purpose of establishing "standards of labor." The individualists who brought about these results have done it because they were men capable of great effort seeking great rewards, intellectual, moral and material. We speak of them as if in the past. They are with us today and will be tomorrow, as long as we protect the freedom of opportunity, the right to try.—*Law and Labor.*

Tomorrow's Motorcoach Legislation

By A. M. HILL[1]

TRANSPORTATION MEETING PAPER

Since the United States Supreme Court handed down a decision, in 1925, that the several States could not regulate interstate motorcoach operation, conditions have become almost chaotic on many routes between centers of population in adjacent States.

Hearings of the Interstate Commerce Commission showed an almost universal demand for regulation of interstate passenger-carrying, but operators of motor-trucks prevented the passage of a bill regulating the interstate operation of both motorcoaches and motor-trucks.

Through the American Automobile Association, the motorcoach operators hope to secure the early enactment of a National law, details of which are discussed in this paper. Moot questions are the policy of protecting railroads against competition, and the date to be inserted in the "grandfather clause."

TO make any prediction of the future of legislation and regulation as applied to motorcoach operations, it is necessary to review briefly the events leading up to the present conditions. I shall refrain, so far as possible, from technical legal references and quotations of court opinions and present my thoughts from the standpoint of an operator rather than as a lawyer would present them.

Prior to March 3, 1925, the problem of interstate regulation was very simple. Practically all the States which had regulatory laws assumed the power to regulate lines crossing State borders in the same way they regulated the lines operating wholly within the State and, as a result, operations entering such States from adjoining States obtained the required certificates of convenience and necessity.

The famous Buck and Bush decisions, handed down by the Supreme Court of the United States on March 3, 1925, altered conditions of motorcoach operation across State borders suddenly and completely. The resulting conditions, particularly in the East and through the more populous sections of the Middle West, became almost chaotic. As there is no restriction of the number of lines that may operate in interstate traffic, the fight has become more or less a question of the survival of the fittest. The advantage, naturally, is possessed by the companies or individuals having the largest assets and the consequent ability to take losses while awaiting legislation that will stabilize their operations.

Prior to the decisions mentioned, the steam railroads of the Country had taken comparatively little interest in motorcoach operation or competition. After these decisions were handed down, motorcoach lines sprang up in great numbers between points where passenger business was extremely heavy and highly developed. This resulted in a sufficient number of complaints to cause the Interstate Commerce Commission, on its own initiative, to hold a series of hearings all over the Country to ascertain the effect upon the railroads of this new competition.

INTERSTATE REGULATION IS DESIRED

I shall not attempt to go into the testimony produced at these hearings except to say that there was practically a unanimous opinion on the part of all those testifying, including all classes of carriers and other interested parties, that there should be some form of regulation over the interstate passenger carriers. Also it was developed, in a number of hearings, that the privately owned automobile rather than the motorcoach had been the chief cause of the serious decline in railroad passenger-revenue. It is assumed that the Interstate Commerce Commission, which has been reviewing and studying this testimony, will make a report to the coming Congress, recommending a specific bill or merely stating its conclusion as to the need of regulation.

The benefits of proper regulation are many, embodying primarily the protection of the public as to the character of the service and the responsibility and reliability of the operator, and placing interstate coach operations on the same high plane of public service that has followed sane and wise regulation of lines wholly within certain individual States.

A committee of motorcoach operators has been working for more than 2 years upon a bill to present to Congress, and upon the formation of the Motor Bus Division of the American Automobile Association this committee's work was taken over by that organization. The committee has worked in closest cooperation with the National Association of Public Utility Commissioners and in addition it has had numerous conferences with railroad and electric-railway representatives.

MOTOR-TRUCK OPERATORS OPPOSE REGULATION

A bill, known as Senate Bill No. 1734, supported by the utility commissioners, was introduced into the United States Senate early in 1926, embodying the regulation of interstate truck lines as well as passenger carriers. Because of great opposition from practically all interests making use of motor-trucks, it was impossible for this bill to pass in that form. A revised bill, known as the Dennison Bill, was introduced during the last short session of Congress, having for its purpose the regulation of passenger carriers only. This bill was based upon the fundamental principle that motorcoach operation is essentially local in character, making use of highways provided by the various States, and that it should be administered and regulated by the various State commissions. All operators who expressed an opinion, and all State commissioners, were unanimous upon this point.

A provision was made in the bill whereby, in the case of disagreement between State commissions and on certain other conditions, an appeal might be taken to the Interstate Commerce Commission. It was felt that the bill must contain a provision which would prevent a condition similar to that of the Shreveport rate case from arising and that, under the provisions of this bill, the result should be the delegation of Federal authority to the State commissions, rather than the further surrender of State rights to the Federal Government. It is felt strongly by all that legislation would be extremely un-

[1] President, The Blue and Gray Lines, Charleston, W. Va.; chairman of the board of directors, motorbus division, American Automobile Association.

wise unless it contained a particular prohibition against a Federal commission assuming authority over coaches operating over the highways of a State in intrastate commerce.

The feature in the Dennison bill causing the greatest amount of discussion at present is the so-called "grandfather clause," which provided that operators having certificates at the time of the handing down of the Buck and Bush decisions should automatically be given certificates, provided they had been in continuous operation since March 3, 1925. All other operations were to be allowed to continue until the final disposition of their cases by the commissions. It is on this point that operators have different opinions, each desiring that the date of this grandfather clause be such as automatically to enfranchise his own operation but not those that have been started subsequently in competition with him. It is therefore apparent that, if this feature is to be incorporated in the final bill, the date selected must be one that is as fair as possible to all types and classes of operation.

A New Bill to Be Drafted

The Legislative Committee of the Motor Bus Division of the American Automobile Association is to prepare the final draft of a bill for presentation at the next session of Congress, after considering the various communications and briefs presented to it by those interested in the development of the industry; and it is hoped that the next bill to be introduced, which will have an excellent chance of passage within the next 6 months, will be constructive in character and will prove a great boon in the development of motorcoach operation throughout the Country.

The problem of interstate regulation, however, is not the only important legal problem that confronts the industry today. A distinct effort is being made by antagonists of motorcoach development to obtain court interpretations of existing laws that will practically prohibit motorcoach operation by other than the owners of the older means of transportation. A very striking decision was that in the Egyptian Transportation Co. case in Illinois; and more recent and even more far-reaching in its effect is the decision of the Supreme Court of West Virginia in the cases of the Baltimore & Ohio Railroad Co. and the Monongahela West Penn Public Service Co. and others versus the State Road Commission of West Virginia, Reynolds Taxi Co. and Bartlett Brothers Bus Co.

In these cases the courts have handed down decisions to the effect that, where routes parallel or compete with existing rail lines, the railroad has first right to the motorcoach certificate.

In West Virginia this decision has met with instant public disapproval on account of the fact that inherent rights to the State highways thus are given to railroads that have contributed nothing to their building and maintenance. The highways of West Virginia have not been built by direct taxation but through the use of funds obtained by a bond issue, in addition to the license and gasoline taxes from motor-vehicles. The interest and sinking fund upon the road-bond issue are provided for from the same source.

In Illinois a very interesting case is developing, which, should it result in a decision against the steam railroad lines, would be far-reaching in its effect. The contention is made in this case that, under present laws and railroad charters, a railroad cannot own a competitive motorcoach line, either directly or through a subsidiary. If some check such as this is not imposed, it is apparent that there will be a general attempt to obtain restrictive and repressive legislation against the motorcoach carrier, either by court interpretations of present laws or by passage of new laws intended to accomplish the same result.

It is equally apparent that this is a two-edged sword and that the motorcoach operators of the Country, in their efforts to preserve their economic life and as a means of combating their antagonists, will succeed in arousing a considerable public sentiment against the railroad companies. Also it must not be forgotten that the motorcoach operators are in extremely close contact with the public and that they, too, represent invested capital.

Concerted Action Is Needed

Sane and far-seeing operators have realized that the best methods of combating antagonistic legislation is through State associations and the further drawing together of all the operators of the Country in a strong National association. Such a National organization is the Motor Bus Division of the American Automobile Association. It is the purpose of this organization to establish a legal research department to give information and help in combating all adverse and antagonistic legislation and to lend assistance in cases throughout the Country in which principles affecting the whole industry are involved.

Unquestionably, the motorcoach has a great and important place in the transportation scheme of America and appeals very strongly to the great mass of our population. It therefore is important and necessary that operators all over the Country work in cooperation within their own States and with the National association. This unquestionably will result in the passing of legislation which will tend to encourage, nourish and stabilize the growth of this young industry which is now covering more than 270,000 route-miles.

External Grinding in Automotive Production

By Oscar A. Knight[1]

Production Meeting Paper *Illustrated with* Photographs

PRECISION grinding is an important factor in reducing the amount of labor required in building a car, and so contributes to placing the automobile within the reach of a greater number of people.

The author describes and illustrates the progress being made in machines and methods for external grinding, including plain cylindrical work, crankshafts, camshafts and other irregular work, and the simultaneous grinding of two surfaces.

Fully automatic grinding-machines are now in use that receive their work from a hopper, do the grinding and eject the work mechanically. There are also semi-automatic machines that require little but loading and unloading. Automatic and mechanical features have been added to some of the other machines to reduce the labor of the operator and enable him to produce more work. One example is the wheel-reciprocating attachment.

A classification of grinding finishes is outlined and, in the discussion, distinctions are drawn between grinding, lapping and honing, each of which is recognized as useful in its place.

IT is reported that in 1916, in a certain factory, 17,000 men produced 650 cars per day; and in 1927, in the same factory, 15,000 men produced 1500 cars per day. This progress from one car per day for 26 men to one car per day for 10 men is a real accomplishment of manufacturing skill, efficient organization and the increased productivity of modern machine-tools.

[1] District manager, grinding-machine division, Norton Co., Detroit.

Precision grinding plays a most important part in the production of automobiles, for without grinding wheels and grinding machines automobiles would be an impossibility except at prices prohibitive to many who now own them. The present demand of the automotive production engineer is for more and more production, to closer limits and with finer finishes. To meet this demand there have been developed new types of grinding machines, new

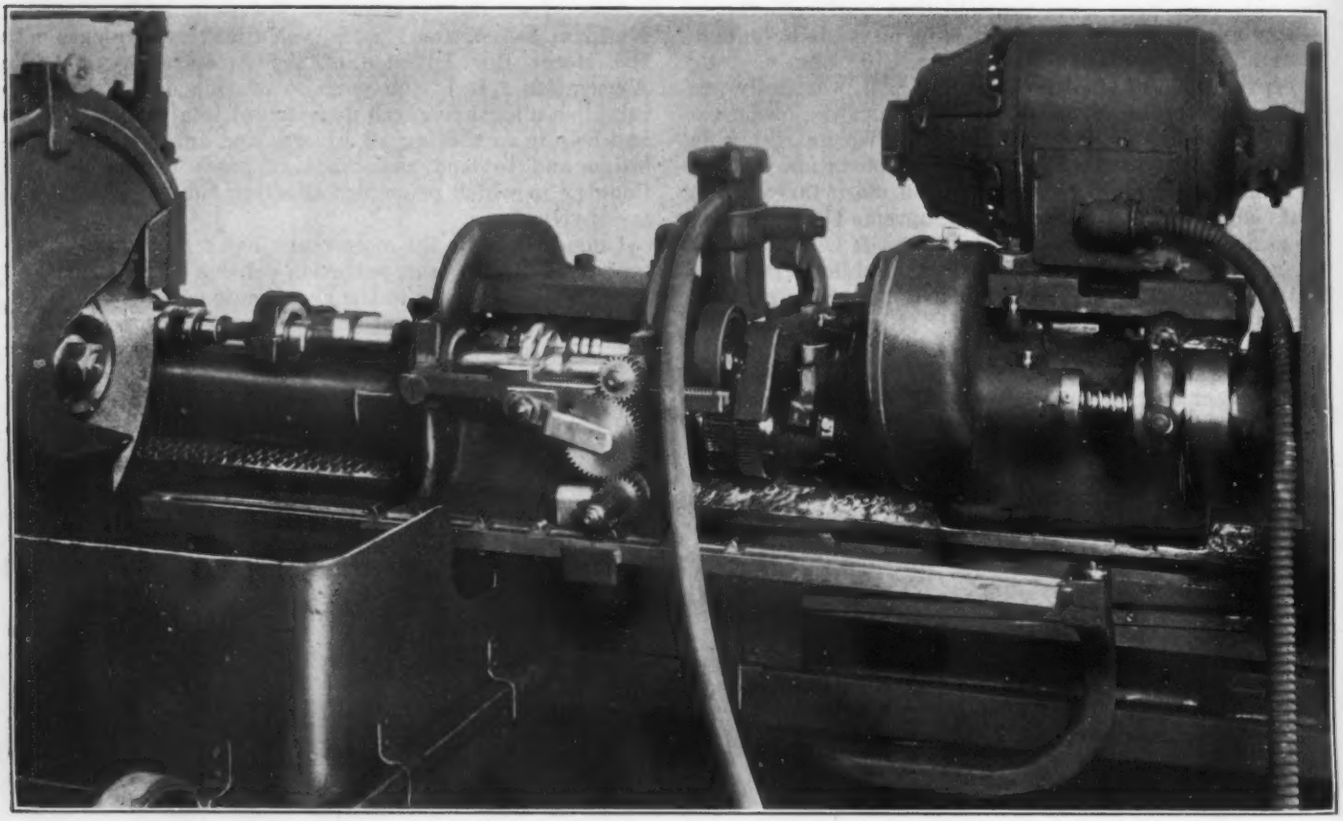


Fig. 1—Automatic Indexing Cam-Attachment
An Air-Cylinder Does the Work of Transferring the Master-Cam Roller, Making the Work of the Operator the Same as in Grinding Spots on a Straight Shaft

forms of machine construction and new methods of grinding. As the grinding machine is the only machine-tool capable of reproducing the same degree of accuracy that is built into it, the importance of precision grinding in such production is evident.

Cylindrical grinding is classified as precision grinding because, with very few exceptions, all such work must come within some exact limits for size and finish. The latest progress in grinding practice has been along lines of multiple-diameter work, wider-faced and larger-diameter wheels and heavier machines. There is also an increase in the use of machines with automatic or semi-automatic control to reduce manual labor, and of ball and roller-bearing construction to reduce maintenance costs. New special attachments have been devised to handle better many operations and to reduce the number of cuts necessary. Two and sometimes three cuts have been grouped into a single operation. Much thought has been given to the development of power-feeding mechanisms with hydraulic, gear, and friction drives, according to conditions.

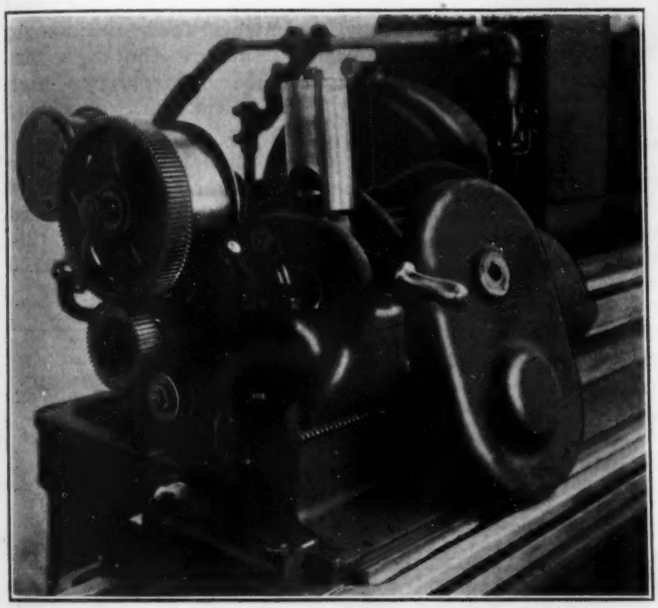


FIG. 2—CHANGE-GEAR TYPE OF CAM-ATTACHMENT
This Attachment Makes Available Six Different Speeds for the Work

The constant demand for better finish and the use of larger wheels has made improvements necessary in the balance of the grinding wheels. It also has caused a larger use of balancing wheel-mounts, equipped with movable weights for bringing back into balance wheels that have developed vibration as they have been worn smaller.

AN AID TO CAMSHAFT GRINDING

In the grinding of camshafts, it formerly was necessary for the operator to lift the master cam from its roller, shift the roller to a position opposite another cam and bring this cam into contact with the roller. These three steps for each shift now are accomplished by a new automatic roll-shifting mechanism shown in Fig. 1. An air-cylinder is connected to the wheel-feed screw so that when the screw is turned backward the master-cam roller is lifted. It is returned to contact just before the wheel begins to grind again, so the operator needs only to move the wheel and the table as though grinding spots on a cylindrical shaft.

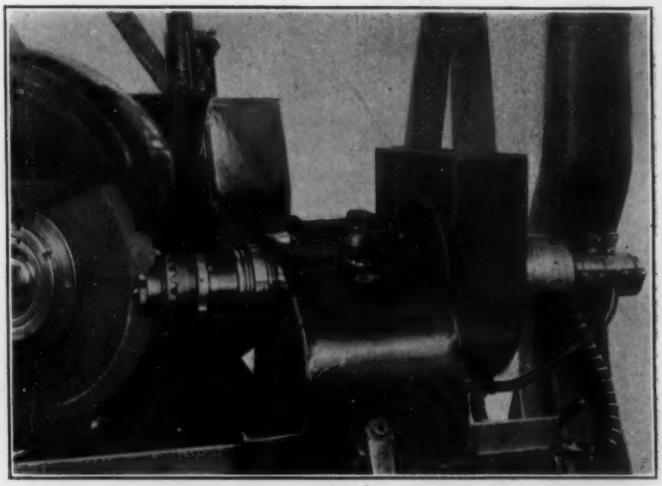


FIG. 3—GRINDING TWO SURFACES WITH ONE WHEEL
By Setting a Formed Wheel at an Angle, a Cylindrical and a Plane Surface Are Ground Simultaneously

This improvement has made possible the production of two more camshafts per hour in one plant and four more shafts per hour in another, increases of 50 to 65 per cent in production. An attachment on the wheel spindle imparts to the spindle a reciprocating motion in the direction of its axis, which assists in securing a high finish, free from grain lines. This reciprocation was formerly secured by the operator, who moved the table back and forth by means of the handwheel.

Closer work on cam-quieting contours is demanded. To help secure these refinements, master-cam-spindle driving-centers are now ground in place by the small electrically driven center grinder which operates from a lamp socket and is quickly attached to or detached from the rocking bar.

Cam shapes are frequently so changed that they upset the grinding conditions and require changes in the number of revolutions of the work. To provide for this, a new change-gear type of cam-attachment drive has been developed, making available six different work-speeds. This drive is shown in Fig. 2.

To meet a demand for a machine to produce cams having re-entrant curves of about 6-in. radius at the

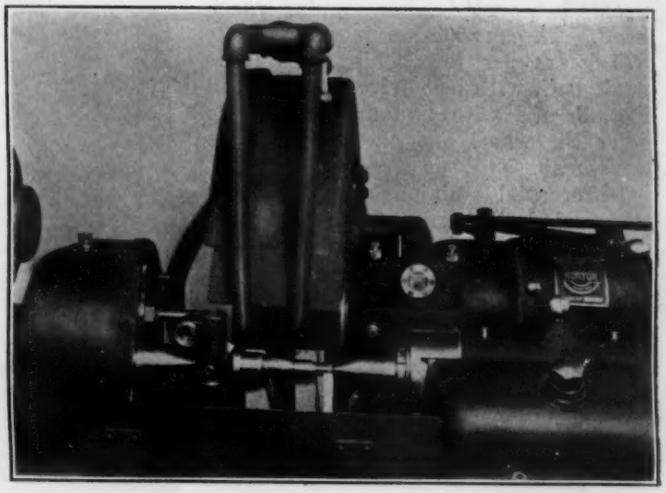


FIG. 4—GRINDING TWO DIAMETERS AT ONCE
This View Shows Two Wheels Trued to Different Diameters, Working in a Semi-Automatic Grinding-Machine

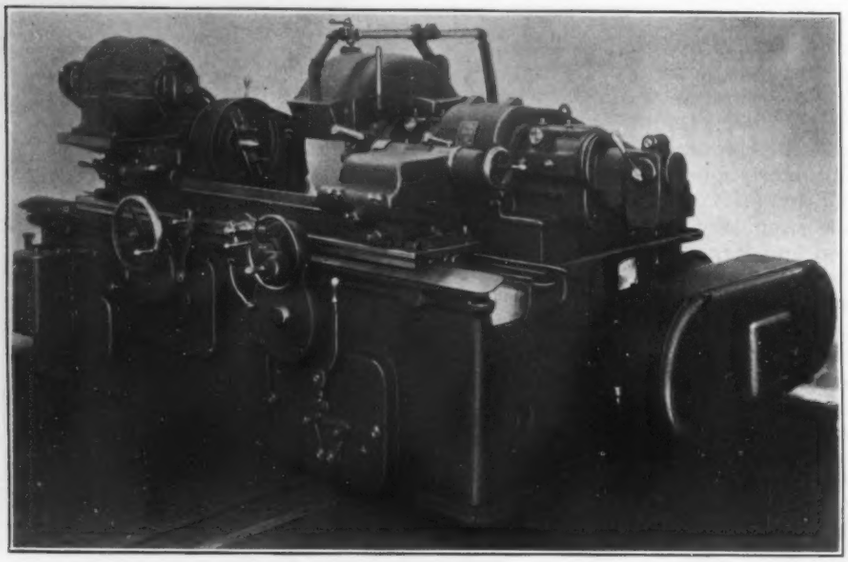


FIG. 5—A HEAVY WIDE-WHEEL MACHINE

This Machine Uses Grinding Wheels 15 In. Wide and 24 In. in Diameter and Narrower Wheels up to 36-In. Diameter. The Projecting Attachment at the Right Reciprocates the Wheel

opening and closing points, an auxiliary grinding-wheel head was developed for wheels of 3 to 10-in. diameter. Wheels of much larger diameter are in common use for cam grinding.

Such work as grinding a relief or elliptical shape on a piston and finishing square transmission shafts and odd-shaped parts can be done in the cam-grinding attachment. The production secured on several items is given in Table 1, the actual number of pieces depending upon the amount of stock removed, the manner in which the work must be held, and the quality of finish required.

Differential side-gears formerly were ground in two operations, a rotary surface-grinder being used on the thrust surface and a plain cylindrical grinder for the bearing surface outside the hub. Fig. 3 shows a differential side-gear mounted in a live-spindle work-head with a special holding-fixture for grinding both surfaces simultaneously. A wheel with a V-shaped profile is mounted in an angular wheel-head. The production is from 80 to 225 gears per hr. This machine is made both with belt drive, as shown in Fig. 3, and with two motors, one to drive the wheel and one to drive the work-head.

Differential pinions have their spherical backs ground on flat-table machines on which are mounted swiveling attachments with adjustment sufficient to provide for any radius desired. The attachment is semi-automatic and gives a production of 6 to 12 pinions per min. with a quality of finish that is good enough generally to require no polishing.

Interest is being shown in simultaneously grinding two diameters, or two spots of the same diameter, with two wheels. Examples of this practice are steering-knuckles, as shown in Fig. 4, axle-drive pinion-shafts, small differential-cases, transmission shafts, and pairs of crankpin bearings for the camshaft of a small engine.

Starting-motor armatures now are being ground on the laminated surface of the rotors. A specially designed sheet-steel exhaust-wheel guard is provided so the grinding can be done dry without injury to the machine, to the operator or to the work. The hourly production is from 80 to 100 armatures.

Most wheel-feed mechanisms are designed to move the wheel-head forward and backward slowly by means of a screw to secure accurate duplication of sizes. This has been the only accurate method until recently, when the rapid lever-operated wheel-feed mechanism was developed. Where the diameters to be ground are between two high shoulders, like crankshaft pins and bearings, or pivot balls driven from their tapered portion in revolving live heads, the rapid lever-feed has proved accurate and helpful. Such work formerly was produced at a rate of from 30 to 40 pieces per hr. With this new lever feed, production has been increased 60 to 100 per cent, with a reduction of manual labor.

TABLE I—HOURLY PRODUCTION WITH A CAM-GRINDING ATTACHMENT

Work	Hourly Production, Pieces
Relieving Pistons	125 to 175
Square Shafts	80 to 100
Brake Cams	60 to 80
Odd Shapes	100

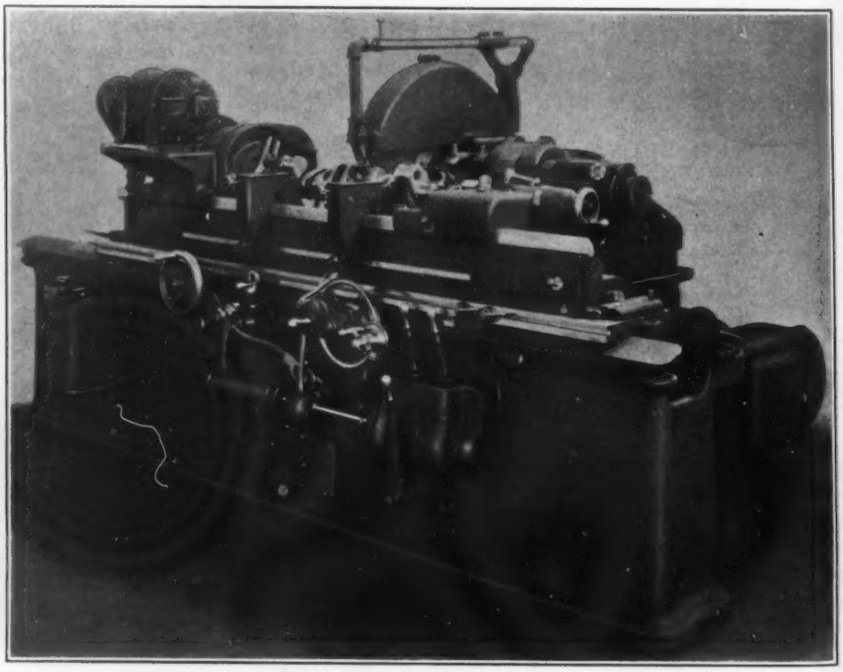


FIG. 6—MOTOR-DRIVEN MACHINE WITH POWER TRANSFERS

This Type of Machine Has Increased the Production on Crankshaft Line-Bearings

Much advance has been made in wide-wheel grinding, particularly on ball-bearing outer races. Heavier machines have been developed, the size shown in Fig. 5 being sufficiently rigid to use 24-in-diameter wheels 15-in. wide, and narrower wheels up to 36-in. diameter. These machines will do twice the work of the earlier and lighter machines. The spindle design incorporates an adjustable reciprocating attachment giving from ⅛ to ¾-in. endwise movement to the wheel. A measuring-gage has been applied that helps in determining the run-out and the amount of stock to be removed. The machines are provided with power feed-mechanism that can be controlled either automatically or semi-automatically or can be hand operated.

Progress has been made also in crankshaft grinding-machines to increase production and reduce costs. The newest machines are heavier than the older ones. They have 30 to 36-in-diameter wheels, with steel guards and power-operated mechanism as far as possible for wheel-head and work-table. Hydraulic, gear and friction drives are used where most suitable, but hand operation is most satisfactory in some cases. One of the latest machines for crankshaft line-bearings is shown in Fig. 6.

Adjustable Weights Correct Balance

Balancing-arbors and collars are made to fit wheel sleeves or wheel mounts. These are provided with adjustable weights to bring into balance new wheels that cause vibration because of their unbalanced condition, or wheels that have worn so as to cause unbalance. The adjustable weights are placed opposite each other to find and mark the light side of the wheel. They are next moved together at the light side, where the maximum counterbalancing effect is produced, and then moved apart, keeping them equidistant from the mark, until the correct balance is obtained. It may be necessary to rebalance in this way two or three times during the life of a wheel to produce the finest work and a highly reflective finish.

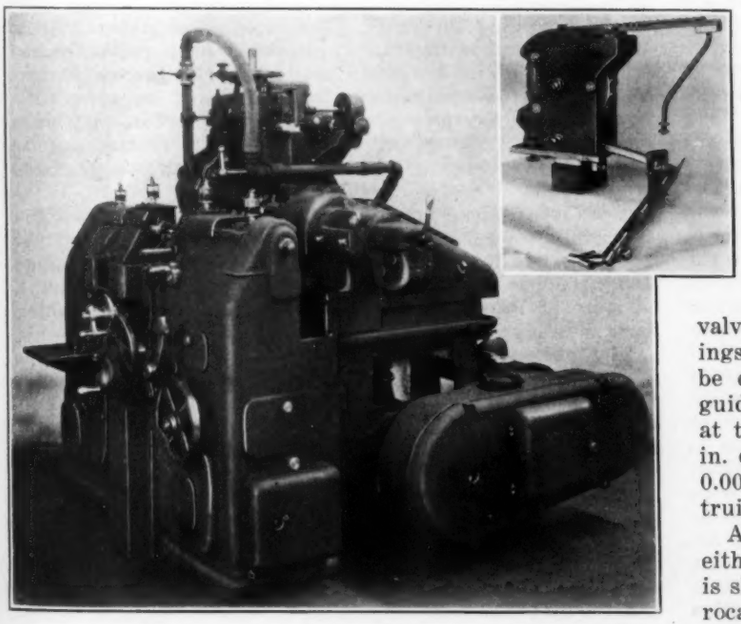


Fig. 7—An Automatic Grinding-Machine

Equipped with an Automatic Feed, This Machine Receives Parts from a Hopper, Completes the Work and Discharges Them Automatically. An Example of the Hopper-Feed Attachment, That for Small Bronze Bushings, Is Shown in the Insert at the Right

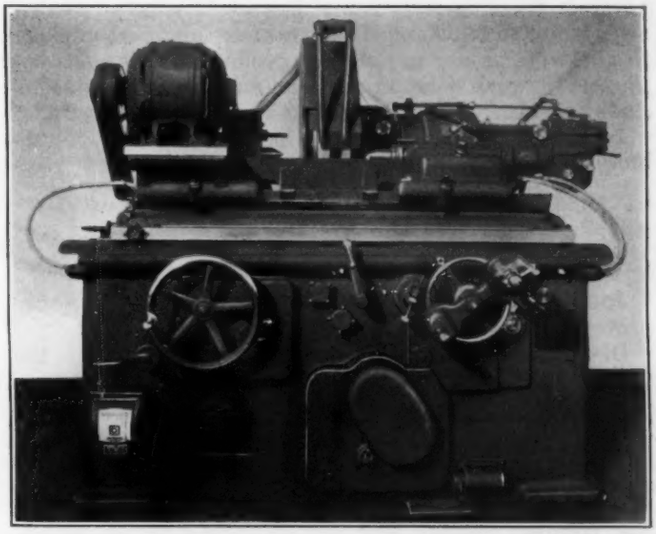


Fig. 8—Semi-Automatic Grinding-Machine

The Cycle Is Completed Automatically by This Machine After the Operator Inserts the Work and Starts It with a Lever. The Wheel-Reciprocating Mechanism Is Shown at the End of the Wheel Spindle

It has been very interesting to note the development of centerless grinding, which is an automatic or semi-automatic method. Automatic grinding is the ultimate aim of grinding engineers, and ever since the beginning of centerless grinding they have been doing the foundation work for completely automatic machines. Several makes of automatic and semi-automatic machines have been put into service. Most of them have been used in roughing operations, but a few have been very successful on precision finish-grinding.

One of the latest fully automatic grinding-machines, shown in Fig. 7, uses a 24-in. wheel of width suitable for the work. The wheel is trued by a power attachment at the top, without removing the magazine equipment. After being ground, the work is ejected automatically and another piece from the magazines takes its place. A typical loading-hopper for this machine is shown in the insert at the right.

The present limit of speed is 12 cycles per min., representing 12 pieces ground singly or more if ground in multiple. For instance, two valve-rollers are mounted on one arbor, for finishing, at the rate of 24 per min., and they are roughed six at a time, at a rate of 48 per min., with the cycle slowed down. Pistons, valves, valve push-rods, piston-pins, and various bushings, bolts and pins are included in the work that can be done on the automatic grinding machine. Valve-guide bushings are being ground to a reflective finish at the rate of 11½ per min., removing 0.004 to 0.006 in. of stock, with limits of 0.0005 in. for diameter and 0.001 in. for concentricity with the bore. With one truing of the wheel, 400 bushings are ground.

A semi-automatic machine that is being used with either one or two wheels for many straight-in-cut jobs is shown in Fig. 8. An attachment is provided to reciprocate the wheel, and a convenient lever enables the operator to grind a shoulder with the left side of the wheel. The operator changes the work on the centers and then moves a single lever to begin the automatic cycle, which starts the rotation of the work and the flow of lubricant and advances the grinding to a stop, then

reverses these operations and leaves the work ground to size, ready to be changed for the next piece. From two to eight pieces per minute are ground on this machine. Classes of work done on the semi-automatic machine include axle shafts and the steering-knuckle shown in Fig. 4.

In describing the finish obtained by grinding, we divide the work into four standard classes: rough, commercial, reflective and highly reflective. To produce a highly reflective finish, great care must be taken in the selecting and balancing of grinding wheels and in determining the rotative speed of the work. This class of finish is expensive and is seldom necessary in the production of automotive parts, but it is used on rolls for sheets of accurate thickness and highest finish.

THE DISCUSSION

JOHN YOUNGER[2]:—Is the trend in grinding toward improved finish or toward reduction in cost?

O. A. KNIGHT:—The trend now is to improve the finish. In some cases an operation is added which, I believe erroneously, is called grinding. It should be called lapping, because it really laps over or overlaps from one high spot to another and removes the sight errors in grinding that cannot be overcome in any other way. All sizing-plugs and all perfect cylinders are lapped. Grinding, lapping, turning and milling should be considered as separate operations. The tendency is toward finer and smoother finishes, which can be produced by this new method.

It is my belief that we shall see machines for putting this ideal finish on cams, still retaining the contours for opening and closing, by this same honing or lapping process. It could not be called lapping on cams, because a reciprocating flat stone, or hone, would be used.

In two or three factories, after they have been ground to a finish free from chatters and flat spots, the cams are buffed to give the same sort of surface that is being produced on piston-pins by lapping machines.

MR. YOUNGER:—Do you use any method of measuring the finish, or do you give the classification according to a man's judgment?

MR. KNIGHT:—We have microscopic photographs of finish, but they are not being used in production work. The laboratories in our factory, and I think in others, examine lapped finishes in that way, and I think they should do so. There would be no reason for photographic examination unless the ideal finish was demanded.

[2] President and editor, *Automotive Abstracts*, Columbus, Ohio.

Decentralization

FOR several years I have been studying the tendency of production and distribution to become more or less local in conformity with economic developments. I have been startled at the extent to which this already has come about. And there will be so much more of it that what has happened thus far will seem small. Last week I spent a half day with a National advertiser who declared that we are about to see the greatest liquidation in business that ever was known. It is his thought that inside of the next five years there will be thousands of changes in the location of factories and any number of consolidations that we have not even dreamed of up to now.

All this has come, and is coming, about because of (*a*) the rapid although necessary increases in freight rates within the last 10 years and (*b*) changes in the transportation and retail distribution of merchandise.

High freight rates have given a tremendous advantage to the centrally located manufacturer at the expense of the producer who has to make his goods in the extreme East or West. High freight rates represent perhaps the most serious difficulty in the way of getting merchandise into the hands of the consumer.

Thus it has become more or less of an economic necessity for the manufacturer of nationally known and used commodities to localize his production and distribution so far as possible. A few years ago he would not have been able to do this, despite the necessities involved, because of lack of power. But now the transmission of electricity over wide distances has made it no longer necessary for him to be located, as formerly, at the source of power. The rapid development of superpower, which is nothing more nor less than the linking up the resources of vast power companies, will still further change the manufacturing situation throughout America.

The whole manufacturing industry of the United States is changing, not only methods and costs of production, but even shifting the location of factories and whole industries.

To understand the full force of all this, we must consider it in connection with the general economic development. It must be remembered that in the last 25 years there have been more inventions which have changed our mode of living than in the preceding 100 years. The rapid development and extension of our transportation methods have revolutionized our lives and our business. Following the success of this long series of extraordinary inventions and improvements, there naturally came a period of rapid expansion. With the greater use of power, we could produce more merchandise and more machinery. With more machinery we produced larger crops.

Even before the war the Country had expanded production to a point where it seemed evident that something must be done to allow demand to catch up with the increased supply. After the war, when the manufacturer began to lose volume, in spite of increasing costs, he immediately began looking for new ways in which to sell his merchandise.

The phenomenal development of advertising during the last 25 years has made it perhaps the leading factor in influencing the sale of merchandise. The big advertisers of the Country are going ahead, on an unprecedentedly efficient scale, with the production and development of consumer acceptance. But the biggest problem in connection with advertising, in my opinion, is the question of how the retailer and the jobber may best ally themselves with these efforts. This is the part of advertising wherein there lies the greatest room for improvement. Manufacturing, for reasons that cannot be changed, is becoming decentralized. It necessarily follows that merchandising must be more and more decentralized to correspond.—Horace C. Klein in *Printers' Ink*.

Activities of the Sections

(*Continued from p.* 630)

enumerate all the present industrial uses of the tractor would be an endless task. Special uses include power for the lumber industry, such as logging; the building of firebreaks in the National forests; freight handling, salt harvesting and numerous uses in the oil fields, quarries and gravel pits as well as in the building and maintenance of airports. He mentioned also the tractor's suitability for military operations and then gave details of how design, proper material, suitable construction, careful operation and adequate maintenance have resulted in the present reliability and economic value of the tractor.

One great change that has been accomplished compared with former practice, due to design, has been an increase of drawbar pull from about 50 to 83 per cent of the rated engine-power. One make of tractor rated at 60 hp. for stationary work was said by the speaker to deliver 50 hp. at the drawbar. Greater accessibility for maintenance and repair and fewer parts are features of present design. Great importance is attached to protecting all moving parts from dust and grit. The use of air-cleaners on tractors was mentioned as the greatest single improvement that has contributed to the effectiveness of the tractor.

Discussion and Transportation Meeting Report

Numerous questions relating to the length of life of tractors, their working conditions, maintenance and rebuilding, and the like were features of the discussion. The use of air-cleaners and oil-filters was commented upon and the subject of effective horsepower was treated. Mr. Reinhart said that some tractors in the logging country have been operating for 4 years and are still operating successfully. He cited instances of tractors working in sand that have been operated for about 9 months without requiring more than minor repairs. Determination of the length of life of a tractor in hours is difficult because working conditions vary so greatly. It was said, however, that the upkeep and replacing of tracks for a track-laying tractor is about the same as for solid-rubber tires on motor-trucks; that is, from the viewpoint of cost.

A feature of the meeting was a very interesting and instructive report made by E. C. Wood, of the Pacific Gas & Electric Co., on the Transportation Meeting held in Chicago, Oct. 25 to 27. The speaker gave a running account of the various sessions of the meeting and presented an outline of the trends of discussion that followed the presentation of papers there. Mr. Wood, who attended all the sessions held at Chicago, conveyed much valuable information to the members and guests of the Section who were not fortunate enough to attend this important meeting.

PRODUCTION METHODS STUDIED

Plant Inspection by Indiana Section Precedes Dinner and Technical Session

Following an inspection of the Delco-Remy Corporation's plant at Anderson, Ind., on Nov. 10, during which special attention was paid to the production methods existent therein, nearly 200 members and guests of the Indiana Section convened at the Grand Hotel for the dinner and technical session held that evening and listened to the address on the subject of production that was delivered by Charles Erwin Wilson, president of the aforesaid corporation. Approximately 70 of the members and guests came from Indianapolis, and 50 from Dayton and Detroit; the others were from Anderson and from various parts of the State. A delightful feature of the dinner was the music furnished by the Delco-Remy Orchestra.

At the business session, Daniel C. Teetor, vice-president and general manager of the General Piston Ring Co., was elected as the representative member to serve on the Nominating Committee of the Society, with F. F. Chandler, chief engineer of the Ross Gear & Tool Co., as alternate. George H. Freers, chairman of the Section and assistant chief engineer of the Marmon Motor Car Co., presided at the technical session.

Production Methods Outlined

In his address, Mr. Wilson outlined the theory of the production set-up in the Delco-Remy plant, the organization that controls production, the method of wage payment, and the armature production-line, using numerous lantern slides to illustrate conditions. He said in part that the production schedule for the current month and for the two following months is determined on the first of each month. Two divisions are made, one showing shipments and the other indicating the various relations of the schedule to the several departments of the plant. The length of time needed for the actual obtaining of the necessary materials and the quantities of materials purchased in advance are determined by the production manager and by the purchasing agent.

Concerning the organization, the speaker said that the heads of departments report directly to the general manager. These include a factory manager, a sales manager, a chief engineer, a production manager, a chief inspector, a service manager, a comptroller, and a personnel director. These have general control of all the activities of the company, and details of their individual duties were mentioned.

The wage-payment plan in use is a modification of a premium system which provided for time-studies of all operations and the setting of standards in regard to the quality of the work of the operators so that, as an average, they can make a premium. The system has been in operation about 8 years, and in some instances the modifications relate to its application to groups of workers instead of to individuals.

The speaker said that the corporation favors the group method of wage payment on a premium basis for three classes of production. The first class includes work that is naturally progressive so that each man performs an operation on a part that is passed to him from the preceding operator, and on which the amount of work he can do is limited by the number of parts which pass through the group. The second class embraces work on which the operators actually help one another and where some more highly skilled men in the group can perform the most difficult part of the work and the less skilled workmen can act as helpers. In the third class mentioned, the work is of such nature that it is difficult to keep a record of the individual operations performed by the workmen in that particular department, such as in a plating department. Descriptive details of how the system works in practice were then presented. Mr. Wilson stated that one of the important features of progressive manufacture of interchangeable parts is the making of accurate time-studies of all operations.

With reference to the armature production-line, the speaker stated that the production methods which were witnessed by the members and guests during the inspection trip have made it possible for the corporation to increase daily production from 350 machines per day 5 years ago to 8000 machines per day at present. One factor of this successful result was stated to have been the degree of standardization which has been effected in generator and motor requirements.

Features of the Discussion

Asked by H. E. Blasingham whether foremen participate in the bonus under the wage-payment system described, Mr. Wilson said that formerly the foremen did participate but that because of difficulty in distributing the premium equita-

bly their participation and that of other non-productive operators was discontinued. Another question by Chairman Freers regarding how generator armatures are balanced brought the reply that since the practice of baking armatures in a vertical position was adopted it has not been found necessary to balance them. Other questions brought statements from the speaker to the effect that the method of progressive manufacture has decreased the cost of inspection, partly due to the fact that the defects are more easily evident as the part passes from operation to operation; that the final inspection of an armature is time-studied; and that the inspectors are not paid a premium because it is believed that such practice would not be conducive to good inspection.

Safety Measures Featured

Regarding the problems relating to safety in the plant, Mr. Wilson said that the guarding of the machinery has been a feature for the last 8 years but that although this is a helpful precaution it constitutes only a relatively small part of the problem. It was found necessary to add to this and combine with it an educational campaign to train the workers to a proper comprehension of dangerous conditions. One of the means adopted to induce the operatives to think in terms of safety was to fly a flag over each building of the plant so long as there was no accident and to pull down the flag when an accident occurred. A similar practice was adopted in some of the departments. In this manner, competition between the several plants and departments was created in that the workers strive to cause their flag to fly the longest. It was said that not more than 50 per cent of the accidents in a plant can be prevented by safety appliances alone, since fully 50 per cent of these accidents in an ordinary plant can be eliminated only by the operatives themselves as they become more careful and comprehend danger and dangerous conditions better.

RESEARCH ON LACQUER SURFACERS

Their Function, Composition and Application Discussed by Cleveland Section

The complexity of the subject of suitable surfacers was emphasized at the meeting of the Cleveland Section held Nov. 14, at Carnegie Hall, the principal speaker being C. D. Holley, director of paint research for the Sherwin-Williams Co. S. L. Bradley, chairman of the Section, presided.

As a representative on the Nominating Committee of the Society, Eugene Bouton was elected; and M. R. Wells was elected as alternate. The technical session was termed a production meeting and was well attended.

Status of Lacquer Surfacers

The finishing of automotive products with lacquer is still in the transition stage, said Mr. Holley, in developing his subject. Sufficient time has not elapsed to provide an adequate background of experience which establishes principles and practices that fully meet the requirements of the production engineer. In other words, many of the things we think we know about lacquer finishes and lacquer undercoatings are either not true or are correct in part only.

The general function of a surfacer is to provide a smooth finish for the finishing coats. Inasmuch as the larger part of the material applied to provide such a surface must be cut away by sanding so as to bring the surface as a whole to the requisite smoothness, a satisfactory surfacer is one that can be applied with the minimum effort, can be sanded with the minimum amount of labor, and can be purchased cheaply, the reason being that most of it is carried away by the wash water during the sanding process. Ease of application and of sanding are essential characteristics of a good lacquer surfacer but, to the speaker's mind, the proper relation of the surfacer to the primer and to the finishing coats of lacquer enamel is the basic requisite.

To present a clear idea of the relation of a surfacer to the finishing system as a whole, Mr. Holley reviewed the elements of former practices. After enlarging upon the details enumerated, he said that lacquer primers dry through evaporation of the solvent present and not through any oxidation of the oils present. They develop maximum adhesion as soon as the solid phase is reached. This adhesion is not materially impaired if the film is again softened through lacquer solvents. This point of superiority over oil primers should justify the general use of lacquer primers were it not for the fact that lacquer primers lose in adhesion after being in service, although the critical point may not be reached for from 3 weeks to perhaps a year.

Permanent adhesion is not a general function of oils, gums, plasticizers or nitrocellulose; rather, it is a specific quality of certain oils or other components of a film, according to Mr. Holley. If the components selected do not possess this specific quality or, if one component is positive and another component is negative in this respect. permanence of adhesion is poor. This, in the speaker's belief, is the reason that lacquer primers have not been satisfactory. The components that have been available for constructing or formulating a lacquer primer did not possess this specific quality of adhesion to the required degree. In his opinion, we are now on the threshold of producing components which will accomplish permanent adhesion through the tendencies of synthetic organic chemistry. In the present state of the art, Mr. Holley considers oil primers which have been baked or thoroughly "force dried" preferable to lacquer primers as a foundation coat for lacquer surfacers, although developments may at any time change this status.

Relation of Surfacer to Lacquer Enamel

The speaker then went on to discuss the basic relations which exist between the lacquer enamel and the surfacer. First, the surfacer must not absorb the lacquer enamel except to a very limited extent. Second, the lacquer enamel must adhere firmly to the surfacer. Some lacquer enamels contain so much oil and plasticizer that this is difficult to accomplish and many materials which otherwise would be advantageous in surfacers tend to reduce the adhesion of the enamel to the surfacer. It is, therefore, obvious that the composition of the surfacer and of the lacquer enamel should bear a very definite relation to each other.

The paint manufacturer endeavors to introduce a reasonable margin of safety in his formulation of his products. In judging the value of a surfacer and balancing that value against the purchase cost, Mr. Holley said that we should not be misled by a laboratory chemical analysis which reports the solid content by weight, because a surfacer may contain a lower solid content by weight and yet have a greater building value than one having a higher content by weight. This difference is, of course, based on the difference in volume displacements of the components used.

In conclusion, the speaker remarked that, notwithstanding their higher cost and lower "building value," lacquer surfacers have come to stay because of their quick-drying and easy-sanding qualities. The remarkable progress already made in the development of lacquer surfacers and the continued activity in improving and perfecting them justifies not only the close attention of the automotive engineer but also a definite share of his time and energy in adapting production operations to bring about the most successful usage of lacquer.

High-Lights of the Discussion

Asked for definitions of several terms, Mr. Holley said that Keystone filler is a natural pigment made from rock which might be described as a cross between slate and soft coal. It carries about 11 per cent carbon and about 89 per cent of silica or silicate and is found near Muncie, Ind. It is a product which has rather a sharp "tooth," and yet is soft and can be sanded or cut away easily. Fossil gums are gums that formed on evergreen trees which grew thousands of years ago. The trees died and became buried in sand; the gum became fossilized. Practically all the high-grade oil-varnish surfacers have gum as their basis. The gum used in lacquer surfacers is of two types, one of which consists of resin chemically combined with glycerine to a neutral composition. The speaker said also that practically

all the lacquers used in the automotive industry and for application to airplane fabrics are nitrate lacquers; that is, the content is in the form of nitro cells and not in the form of acetate cells.

Mr. Holley remarked that two very different propositions are presented in connection with the successful application of lacquer to wood and to metal. Lacquer of good durability and moderate cost can be applied to metal, and the time interval between the beginning and the completion of the work is short; but, for finishing wood that is to be continuously exposed to the weather, nearly as much time for the application of lacquer is needed as for the old-type oil-primer oil-surfacer and varnish system. For successful application on wood, it seems to be definitely established that there must be thorough penetration of the surface fibers of the wood by some material which not only will penetrate but will remain and seal the section of the wood near the surface so that moisture cannot penetrate and cause the wood fiber to swell.

USES OF MICROMETER DIAL-GAGES

Ames Tells New England Section of Applications in Manufacture and Service

At the Engineers Club in Boston on Wednesday evening, Nov. 9, the New England Section met, with Secretary William M. Clark presiding, and listened to an address by Warren Ames, of the B. C. Ames Co., following the serving of a dinner.

Inspection methods have not kept pace with production methods, according to the speaker. It often has been necessary to employ more inspectors to keep pace with the work, whereas improved inspection methods might make this unnecessary.

Ring gages, plug gages and micrometers all depend for their accuracy on feeling. This applies even to ratchet micrometers, because their reading will vary according to the rate at which the barrel is turned down. There are also amplified lever gages, fluid gages with diaphragms, electric gages and dial micrometer-gages.

These dial gages are graduated according to metric or inch scales. They are made by several different manufacturers and most of them operate with a rack and pinion and multiplying gear by means of which a slight movement of the spindle makes a large movement of a hand which can be read on the dial. In some, the multiplication is so great that there are graduations nearly ⅛ in. apart to show each 0.0005-in. motion of the spindle.

Gages of this general type were used first at the beginning of the century. The construction of the earliest gages was such that the motion of the pointer hand was not proportional to the movement of the spindle. They could not be read directly and were used only for comparisons. Most of the gages made now are graduated.

Variations Read Easily on Dial

Dial gages are used generally by setting them at zero at the desired dimension. Variations from this dimension are shown by the position of the hand. Great accuracy is needed in the delicate mechanism of the gage to assure the required precision in the instrument.

Automobile plants use dial gages to a large extent for inspection, because they show the variation in such a way that the inspector can read it all day without eye strain. As the reading is quick, high production is secured.

Special fittings are required for various kinds of inspection. One testing fixture used on crankshafts embodies 27 indicators, said Mr. Ames. Gages of this sort are used also on grinding-machines for showing the size of work without stopping the cutting.

Dial indicators are adapted to gears, crankshafts, pistons, piston-pins, valves and many other automotive parts. They are incorporated in hardness-testing instruments and in other standardized testing devices, one of the best known of which is the cylinder gage used largely in factories and service stations.

In other industries they are used to measure the thickness of such widely diversified products as soap flakes, rubber, paper, mica, and a film of varnish. They are used also to measure the expansion of a gun or of a tank under pressure, and to measure the force of the explosion in a gun by the resulting deformation of a lead plug. Irregular outlines in gun parts are checked with a profile gage in which a dial follows a master profile used as a cam and shows any variation therefrom in the part being inspected.

Many Uses in Service Stations

A variety of gages for use in automotive service stations is being developed. One of them shows the out-of-roundness of crank-pins and piston-pins, another shows whether a valve stem is straight and true with the head, and still another is being developed to show whether the bore of an automobile engine is true with relation to the crankshaft or, rather, with the cylinder-head seat.

One of the latest service-station tools is a bearing tester which embodies a gage that can be attached to the cylinder by means of a magnet. A rubber vacuum-cup is applied to the top of the piston. Any looseness in the bearings can be shown and measured on the dial by pulling and pushing on the piston with this vacuum cup.

Mr. Ames and those who took part in the discussion agreed that the use of devices of this sort in service stations puts the stations on a more businesslike and efficient basis. A car owner can be shown the amount of wear on the dial instead of merely being told that his cylinders need regrinding or that certain other work needs to be done; and the inaccuracy of a part can be determined definitely before starting work upon it.

A few details of the new Ford car that have come under his observation were revealed by Mr. Ames, who said that the piston-pins are held in the split die-cast aluminum pistons by two 5/32-in. pins. A novel feature is that the two connecting-rod bolts are forged integral with the rod and are hollow-milled and threaded during the machining operations on the connecting-rod.

It has been announced that the New England Section, in cooperation with the Massachusetts State Department of Education and the Massachusetts Institute of Technology, has arranged to offer a course in automobile mechanics for service station men this winter. Prof. Dean Fales will be the instructor of a class limited to 50 members.

PRESENT AVIATION DEVELOPMENT

Chicago Section Discusses Commercial Air-Transport Equipment and Practices

Several phases of commercial aviation were portrayed and described for the 60 or more members and guests of the Chicago Section at the meeting held Nov. 8 in that city at the headquarters of the Western Society of Engineers. Motion pictures were shown which depicted features of special interest in connection with the operation of the Stanolind, an airplane used by a large oil company to further its commercial interests, and these were commented upon by J. P. Porter, of the company. Remarks were made by representatives of several air-transport lines; actual experiences bearing on engineering features of aviation were cited, these having occurred during commercial air-transport flights; and the various points brought out were discussed profitably by the numerous authorities in their several subjects who were present.

F. G. Whittington, Chairman of the Section, presided. During the business session, Lee Oldfield, of the Package Car Corporation, was elected unaminously to represent the Section on the Nominating Committee of the Society, with H. F. Bryan, of the International Harvester Co., as alternate.

In the flights made to date by the airplane described by Mr. Porter, it has flown 450 hr., has carried more than 2000 passengers, and has covered more than 40,000 miles without having been forced down. Two pilots and a mechanic con-

stitute its crew, the pilots relieving each other alternately in their duties. This practice also affords an added factor of safety in that it is unlikely that both pilots will be incapacitated at the same time.

Single versus Multi-Engine Airplanes

L. D. Seymour, of National Air Transport, Inc., said in part that determination of the route of an air-transport line must result from a study of the topography of the country it traverses, the average meteorological conditions, wind direction and velocity, and the possible landing-fields. In his opinion, future regularly operated air-transport craft will be powered with three engines. He stated that troubles with the water cooling-system in engines so equipped and troubles with the lubrication system in air-cooled engines are the most serious and the most likely causes of aircraft-engine failure. The trend of design is toward air-cooled engines. As to engine trouble caused by failure of the fuel to feed properly, the two forced landings of the airplanes operated by his company due to this cause were, in one case, water in the gasoline and, in the other, failure or stoppage of the fuel-pump check-valves. He advocates filtering all the gasoline that is used in an aircraft engine through chamois skin.

Other Subjects Discussed

The discussion also centered on other topics, such as brakes for airplanes, maximum and minimum take-off and landing-speeds, wing spread and wing loading, average altitude at which commercial flights are made, means of procurement of landing-fields, and other pertinent topics.

Regarding landing-fields, Mr. Porter said that civic organizations in the different cities are evidencing great interest in securing them. In some instances these organizations have leased suitable land and have improved it sufficiently for use as an airport; in other cities large sums have been expended to create a permanent airport. In general, there is greater and greater realization that adequate facilities must be provided if a city has any expectation or desire to secure the benefits accruing from air transport.

World Leadership in Service Facilities

THE United States leads the world in automobile service-station facilities and this leadership is due largely to the popularity of driving one's own car in the United States. In other world motoring countries the chauffeur-driven automobile had been almost universal until very recently and the service station was therefore less in demand. In these countries the automobile had also been used primarily for pleasure and the owners were tolerant of delays in obtaining parts and repair service.

Today all this is changing. The efficient and factory-organized and supervised service on parts and repairs of the large American motor-car manufacturers has been extended to practically every important country in the world and has been a large factor in strengthening the position of the American car in competitive markets. Complete and capable local service is an absolute necessity to the continuance of the owner-driver system, and the increasing popularity of this system abroad is bringing about a rapid improvement in service facilities.

Although labor-saving devices are comparatively little used abroad, maintenance cost has been moderate by reason of low labor-costs. The increasing use of such equipment in these countries, however, is expected to reduce still further the cost of motoring and thus enlarge their motor-vehicle markets. In the less developed countries of the Antipodes, southern Africa and South America the scarcity of skilled mechanics has given a great impetus to the development of service stations equipped with labor-saving machinery, while in the Orient the abundance of semi-skilled labor, at very low wages, has retarded this movement.

In addition to the enlarged vehicle markets that follow upon improved service facilities, in which our makers share extensively, this movement has resulted in large increases in sales of American automotive-service appliances abroad, even in those countries with well-developed small-tool industries of their own. This is a consequence of the activities of American makers in developing tools and other service appliances that are peculiarly suited to automobile servicing and saving of time and labor.

The exports of those items of service apparatus peculiar to, and intended for use in servicing automobiles, has shown a remarkable increase since they were first separately classified in the calendar year 1923. In that year the wholesale export value of these articles was $1,076,359. In 1924 it increased to $2,841,453; in 1925, to $5,432,711; in 1926, to $6,861,746; and for the first 9 months of 1927 it totaled $6,102,779. This very satisfactory increase shows unmistakably the trend toward increased automobile-service facilities abroad.—From a report by the automotive division of the Department of Commerce.

Speed with Safety

ONLY a few rules are necessary to greatly reduce the number of accidents occurring on the highways. Speed is not one of these. If the driver of an automobile felt that the road ahead of him was and would remain reasonably clear of obstructions, the fear of greater speed on his part would be greatly reduced. If he were sure that there would be no parked vehicles in the line of traffic, if he were sure that no vehicle would come out from an obscure side road at high speed, simply because it had the right of way, and if he were assured that the driver in front of him would make a right or left-hand turn only from a right or left-hand lane, he would not be afraid to drive at a reasonable rate of speed, and he could do so with the maximum of safety. If we will do just these things and forget about speed; if we will remove the groove in which the police mind runs, and with it the motoring mind, we will immediately greatly reduce the number of accidents. We should certainly reduce them as greatly as they have been reduced on the boulevards of Chicago.

When we are reducing the number of accidents, we shall be greatly increasing the use of the highways. It is essential that both of these things be done to prevent the breakdown of the highway transportation-system of the Nation. It is necessary that some change be made and made quickly, and the outstanding need seems to be the elimination of the ridiculous speed limits provided at the present time.—From the affirmative presentation by John N. Mackall in a debate on speed limits at the National Safety Congress.

November Council Meeting

A SESSION of the Council was held in Detroit on Nov. 21, those attending being President Hunt; First Vice-President Wall; Second Vice-President Patitz; Councilors Chandler, Sparrow and Veal; and J. W. White, F. G. Whittington, H. T. Woolson, and L. M. Woolson, who have been nominated to serve on the 1928 Council.

A financial statement as of Oct. 31, 1927, was submitted. This showed a net balance of assets over liabilities of $208,373.68, this being $24,459.18 more than the corresponding figure on the same day of 1926. The gross income of the Society for the first month of the present fiscal year amounted to $31,630.00, the operating expense being $30,677.84. A statement for the 1927 fiscal year, also submitted, showed a net balance of assets over liabilities of $32,690.37 more than for the 1926 fiscal year, the gross income for the fiscal year 1927 being $379,693.78, and the operating expense $348,221.28.

Quebec Selected for Summer Meeting

It was the sense of the Council that the 1928 Summer Meeting of the Society be held at Chateau Frontenac, Quebec. It was also decided that the 1928 Annual Meeting of the Society to be held in Detroit, Jan. 24 to 27, should be held at the Book-Cadillac Hotel.

The election of 67 members, 4 grade transfers, 4 reinstatements, 4 reapprovals, and the dropping of 5 members, upon which the Council had acted by mail vote, were confirmed. Fifty-three additional elections to membership were approved, as well as 6 transfers in grades of membership. The resignations of 65 members were accepted, and the names of 198 members were stricken from the rolls of the Society for nonpayment of dues. Two Affiliate Members also were dropped for nonpayment of dues. Three reinstatements to membership were approved, as well as the reinstatement of one Affiliate Member. Five applications were reapproved. The mail vote on the election of one Affiliate Member was confirmed.

Standards Committee Appointments and Assignments

The following subjects were assigned to divisions of the Standards Committee as indicated:

Four-Speed Gearshift-Lever Position for Passenger-Cars—Transmission Division

Bearings for Industrial Electric Motors—Ball and Roller Bearings Division

Multiple Signal-Lamp Connectors—Electrical Equipment Division

The appointment of J. A. Anglada and Walter M. Norton as the Society representatives on the Sectional Committee on Small Tools and Machine-Tool Elements was confirmed. It was understood that one other member was to be appointed. The appointment of J. R. Adams on the American Society for Testing Materials Committee A-1 on Steels Subcommittee XII on Chemical Analysis, and of Joseph Berge on the Sectional Committee on Standardization of Pipe Threads, were also confirmed. C. B. Veal was appointed to succeed C. M. Manly on the Main Committee of the American Engineering Standards Committee.

It was decided that the S.A.E. Handbook should be issued once a year instead of every 6 months, as heretofore.

The constitution of the Student Group at the General Motors Institute of Technology was approved.

Vote To Record Manly Resolution

It was voted that the following resolution be placed upon the records of the Society:

> Whereas, the membership of the Society of Automotive Engineers are deeply conscious of the irreparable loss that they have suffered in the passing of Charles Matthews Manly and
>
> Whereas, the services of Charles Matthews Manly to the aeronautical art can never be overestimated and should never be forgotten, therefore
>
> *Be It Resolved* that the members of the Society in Aeronautic Meeting assembled desire to make expression of their own grief and of their sympathy with the family of Mr. Manly;
>
> *Be It Further Resolved* that this resolution shall be spread upon the records of the Society and that a copy hereof shall be transmitted to the family of Charles Matthews Manly.

The matter of a war memorial to engineers, to be erected in the Louvain Library in Belgium, was discussed and it was understood that printed matter in this connection would be mailed to the membership.

A resolution thanking Edward P. Warner for his work in connection with the Aeronautic Meeting in New York City was passed.

The Competition of Capital

THROUGHOUT the business world today the complaint is common that, while the volume of business is large, profits are small and uncertain. This means that, as a result of the increasing amount of capital available to the industries, their capacity has been increased until only those which are most effectively equipped and capably managed are able to make profits. Everywhere it is said that the capacity of the industries is in excess of the demand for products, but, except at brief periods, this is always true and is a sign of industrial progress. It is also true, however, that much of the capacity is not of the latest and most economical kind, but in the way of elimination. There is always profit for the low-cost producers, but the high-cost producers go to the wall as industry moves forward.

There is no competition so irrepressible as that of new capital with old. The stream of new capital which is always coming upon the market is bound to force itself into employment somewhere, and it has an advantage over the old investments in being able to utilize the very latest offerings of science and invention. In these days, when the frontiers of scientific knowledge are being extended rapidly, when the facilities for research are daily increasing, and when improvements in industry are constantly producing a flow of new capital, it may be expected that the industrial pace will be faster in every succeeding decade.—From an address by George E. Roberts, vice-president, National City Bank, before the annual convention of the National Association of Manufacturers.

Applicants Qualified

The following applicants have qualified for admission to the Society between Oct. 10 and Nov. 10, 1927. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff) Affiliate; (S M) Service Member; (F M) Foreign Member.

BOTTS, EDISON (M) assistant field engineer, tire development department, United States Rubber Co., *Detroit;* (mail) 954 North Beaconsfield Avenue.

BRENNAN, MARTIN J. (A) sales engineer, Willard Storage Battery Co., Cleveland; (mail) 5946 Cass Avenue, *Detroit.*

CAPPA, GIULIO CESARE (F M) mechanical engineer, Studio Tecnico Ing. G. C. Cappa, Via Pier Carlo Boggio 24, *Turin* (105), *Italy.*

CHANDLER, WILLIAM A. (A) 241 Exchange Street, *New Haven, Conn.*

COOK, FRANZ W. (J) test assistant, Chevrolet Motor Car Co., Detroit; (mail) 31 Maywood Avenue, *Pleasant Ridge, Mich.*

COUGHTRY, WILLIAM REED (M) research engineer, engineering department, Buick Motor Co., *Flint, Mich.;* (mail) Durant Hotel.

DAKIN, HENRY (A) superintendent of buildings, motor equipment and supplies, Michigan Bell Telephone Co., *Detroit;* (mail) 1365 Cass Avenue.

DODGE, FREDERICK N. (A) general sales manager, J. C. Haartz Co., *New Haven, Conn.;* (mail) Apartment No. 37, 255 Whitney Avenue.

FLETCHER, HAROLD A. (J) district service manager, Marmon Motor Car Co., Kentucky Avenue and Morris Street, *Indianapolis.*

GOULD, JOHN (M) designer, Continental Motors Corporation, Detroit; (mail) 1357 Lakepoint Avenue, *Grosse Pointe Park, Mich.*

GRUNDER, LAWRENCE J. (J) mechanical engineering student, California Institute of Technology, Pasadena, Cal.; (mail) 4063 Budlong Avenue, *Los Angeles.*

HARVEY, PAUL D. (M) secretary and treasurer, Garage Service Co., 212 South Peoria Street, *Chicago.*

HEGAN, GEORGE G. (A) district service manager, White Co., *Buffalo;* (mail) 2068 Main Street.

HOPKINS, JOHN M. (J) student, Rolls-Royce of America, *Springfield, Mass.;* (mail) 8 Blake Hill.

JONES, A. M. (A) engineer, Willis-Jones Machinery Co., Inc., Ninth Avenue, South and Bayview Streets, *Seattle.*

KEARFOTT, A. J. (A) research and development, General Motors Corporation, Research Laboratories, *Detroit;* (mail) Apartment No. 8, 1211 Hudson Avenue.

LANG, HENRY W. (J) assistant engineer, New York Telephone Co., Brooklyn, N. Y.; (mail) 3042 Bainbridge Avenue, *New York City.*

LEARY, THOMAS J. (A) Chicago branch manager, Biflex Corporation, Waukegan, Ill.; (mail) 7141 Jeffery Avenue, *Chicago.*

MACKENZIE, W. C. (M) chief engineer, Acme Motor Truck Co., *Cadillac, Mich.;* (mail) 505 Lincoln Street.

MARDUS, HERBERT H. (A) manager of parts department and purchasing agent, Newton A. Barnett, *Elizabeth, N. J.;* (mail) 720 Van Buren Avenue.

MASON, JOSEPH B. (A) assistant superintendent of motor-transport division, Pure Oil Co., *Mexia, Tex.*

MCCANN, CHARLES SUMNER (J) research engineer, Delco-Light Co., *Dayton, Ohio;* (mail) 207 Forrer Boulevard.

MERTZ, HOWARD A. (J) superintendent of motor transportation for producing departments, Marland Refining Co., *Ponca City, Okla.;* (mail) 911 East Cleveland Avenue.

MILLER, ERNEST FRED (J) steam turbine design, Westinghouse Electric & Mfg. Co., Philadelphia; (mail) 310 Trites Avenue, *Norwood, Pa.*

MORGENROTH, HUGO (J) designer, Bijur Lubricating Corporation, *New York City;* (mail) 2850 Broadway.

NAGEL, A. (F M) professor of mechanical engineering, Dresden Technischen Hochschule, *Dresden, Germany;* (mail) Altenzellerjtoke 29.

NAQUIN, ARTHUR J., JR. (J) engineer, New Orleans Public Service, Inc., 3233 Magazine Street, *New Orleans.*

NEUMANN, WALLACE A. (J) draftsman, Stearns Motor Mfg. Co., *Ludington, Mich.;* (mail) 601 Fifth Street.

NIEDERLE, LUBOR J. (A) motor car sales engineer, Skoda Works, Ltd., Prague-Pilsen, Czechoslovakia; (mail) 228 Kounicova Street, *Prague IV, Czechoslovakia.*

OBERHOLLENZER, JOSEPH (A) electrician, Park Central Motors, New York City; (mail) 22 74th Street, *North Woodside, N. Y.*

OSBORN, EARL D. (M) president and editor, Aviation Publishing Co., 250 West 57th Street, *New York City.*

PERRINE, LESTER E. (M) research engineer, General Motors Corporation Research Laboratories, *Detroit;* (mail) 688 Lawrence Avenue.

PFEIL, A. LESLIE (A) sales engineer, General Motors Co., 1101 Union Trust Building, 925 Euclid Avenue, *Cleveland.*

POORE, MORRIS C. (A) San Francisco branch service manager, Fageol Motors Co., Oakland, Cal.; (mail) 277 Henry Street, *San Francisco.*

PORTER, LEWIS MORGAN (J) junior mechanical engineer in aircraft engine laboratory, Naval Aircraft Factory, *Philadelphia;* (mail) Yale Club, 1221 Spruce Street.

RAFFONE, WILLIAM P. (J) junior engineer in service department, G & O Mfg. Co., *New Haven, Conn.;* (mail) 54 William Street.

SCHMIDT, B. F. (M) vice-president, Gillett-Schmidt Corporation, *Los Angeles;* (mail) 2250 Crenshaw Boulevard.

SCHUTT, ARTHUR J. (M) engineer, Chandler-Cleveland Motors Corporation, *Cleveland;* (mail) 732 East 103rd Street.

SERRICK, L. F. (A) general manager, Defiance Automatic Screw Co., *Defiance, Ohio.*

SKODA WORKS, LTD. (Aff) *Prague, Czechoslovakia;* V. Klement, director and representative.

STEINBRUGGE, HERMAN (A) vice-president, Weymann American Body Co., *Indianapolis;* (mail) 1145 East 22nd Street.

SWENSON, ANDREW S. (A) owner, Swenson Motor Co., 1602 East Douglas Avenue, *Wichita, Kan.*

THULSTRUP, CARL A. (A) mechanical draftsman and checker, Doehler Die-Casting Co., *Pottstown, Pa.;* (mail) Box No. 353, 938 High Street.

WATSON, WILLIAM FRED, JR. (F M) superintendent of garage and internal-combustion engines, Ulen & Co., Barranquilla, Colombia; (mail) 226 Alamosa Avenue, *San Antonio, Tex.*

VOL XXI

NO-6

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

DECEMBER 1927

TRANSPORTATION MEETING NUMBER

SOCIETY OF AUTOMOTIVE ENGINEERS INC.
29 West 39TH STREET NEW YORK, N. Y.

Here is the big idea:

The thing that is uncomfortable in motoring is excessive force of spring rebound. Excessive rebound force is the thing that throws us up and off the seat. The greater the excess of this force, the greater becomes the throw.

Other devices deal with these throws. In different manners and by different means and in different degrees they attempt to stop the throws.

Watson Stabilators do not attempt to do anything of that sort. The Watson thought has always been that it would be better to prevent these throws than to attempt to stop them **after they have become throws.**

To do this has by no means been an easy matter. We finally accomplished our desire, however—and very simply.

Watson Stabilators simply **use up** a certain amount of the rebound force. They start using up this excess force before the excess force can act against the car body and passengers. The instant the force starts to move the axle and frame apart, it finds that it has four Watson Stabilators to drag as well as the car body to lift. Dragging the Stabilators uses up the excess force, and hence the force which remains in the springs to raise the car body is not sufficient to throw the body—merely sufficient to raise it, nicely, gently.

Watson Stabilators have again proved to the world that old, old truth, that it is better to **prevent** something than to try to stop it after it has happened.

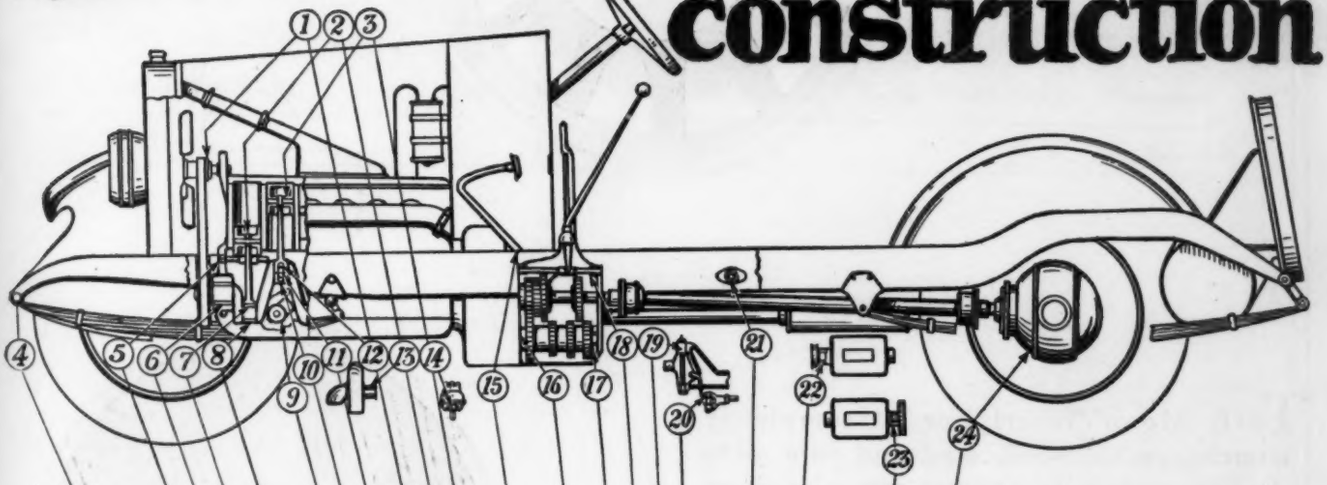
Original and Sole Manufacturers of Stabilation

JOHN WARREN WATSON COMPANY
Philadelphia
(Detroit Branch: 3081-3083 Grand Boulevard, East)

WATSON STABILATORS

Use up the Force which would Otherwise Throw You

24 opportunities *for* better automobile construction



FEDERAL-MOGUL Bearings, Bushings and other related products have 24 important applications in practically every motor car built. Wherever used, they minimize friction and wear. They insure for the manufacturer who uses them, a reputation for long-lived, trouble-free service. More than 150 automotive manufacturers specify them as standard equipment. Complete research laboratory facilities are available for co-operation with automotive engineers.

FEDERAL-MOGUL CORPORATION
Detroit, Michigan

Key to Drawing

1. Fan Pulley Bushing
2. Connecting Rod Bushing
3. Piston Pin Bushing
4. Spring Eye and Shackle Bushing
5. Camshaft or Eccentric Shaft Bearing or Bushing
6. Main or Crankshaft Bearing
7. Connecting Rod Bearing
8. Bearing Anchor Screws
9. Steering Gear Eccentric Bushing
10. Connecting Rod Nut
11. Connecting Rod Shim
12. Connecting Rod Bolt
13. Water Pump Bushing
14. Distributor Bushing
15. Brake Pedal Bushing
16. Transmission Intermediate Shaft Washer
17. Transmission Intermediate Shaft Bushing
18. Transmission Shift Fork Shaft Bushing
19. Steering Knuckle or King Pin Bushing
20. Steering Knuckle Tie Rod Bushing
21. Brake Cross Shaft Bracket Bushing
22. Generator Bushing
23. Starter Motor Bushing
24. Brake Actuating Camshaft Bushing

The Complete Federal-Mogul Line Includes

Bronze-Back, Babbitt-Lined Bearings
Die-Cast Babbitt Bearings and Bushings
Bronze Bushings
Bronze Washers
Bronze Castings
Babbit Metals
Bronze Cored and Solid Bars

Mogul FEDERAL

Licensed Under Letters Patent of the United States No. 1,455,939; No. 1,302,584; No. 1,302,838; No. 1,340,337.

Your Reputation is Safe with Federal-Mogul—World's Largest Engine Bearing Manufacturers.

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

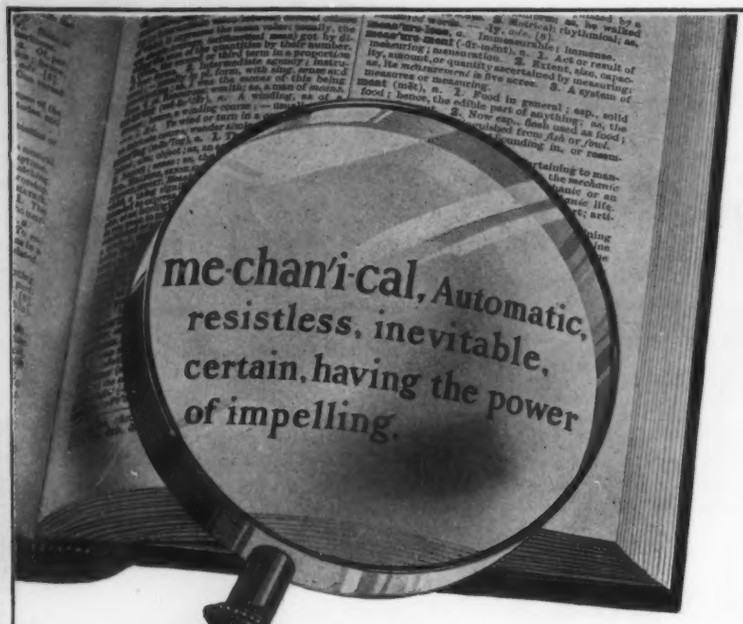
Published by the SOCIETY OF AUTOMOTIVE ENGINEERS, INC., 29 *W. 39th St., New York*

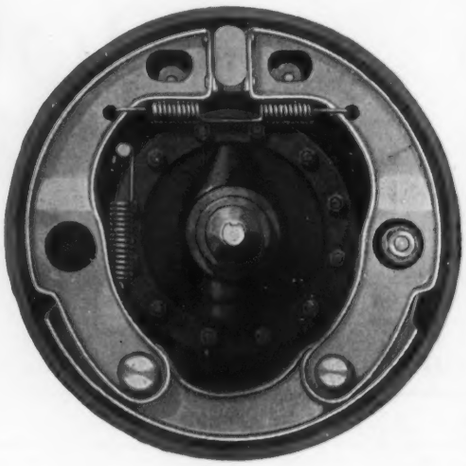
Issued monthly, $1 a number, $10 a year; foreign $12 a year; to members, 50 cents a number, $5 a year. Entered as second-class matter, Aug. 23, 1917, at the post office at New York, N. Y., under the Act of Aug. 24, 1912. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of Oct. 3, 1917, authorized on Aug. 2, 1918.

J. H. HUNT, *President* COKER F. CLARKSON, *Secretary* C. B. WHITTELSEY, *Treasurer*

Vol. XXI December, 1927 No. 6

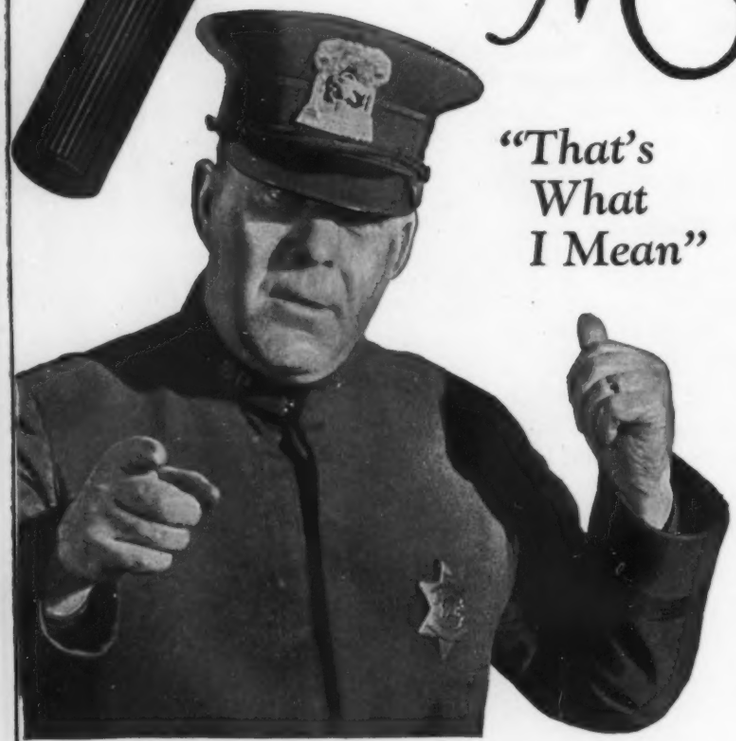
CONTENTS





Fully protected by patents and applications in U. S. and abroad

Mechanical



"That's What I Mean"

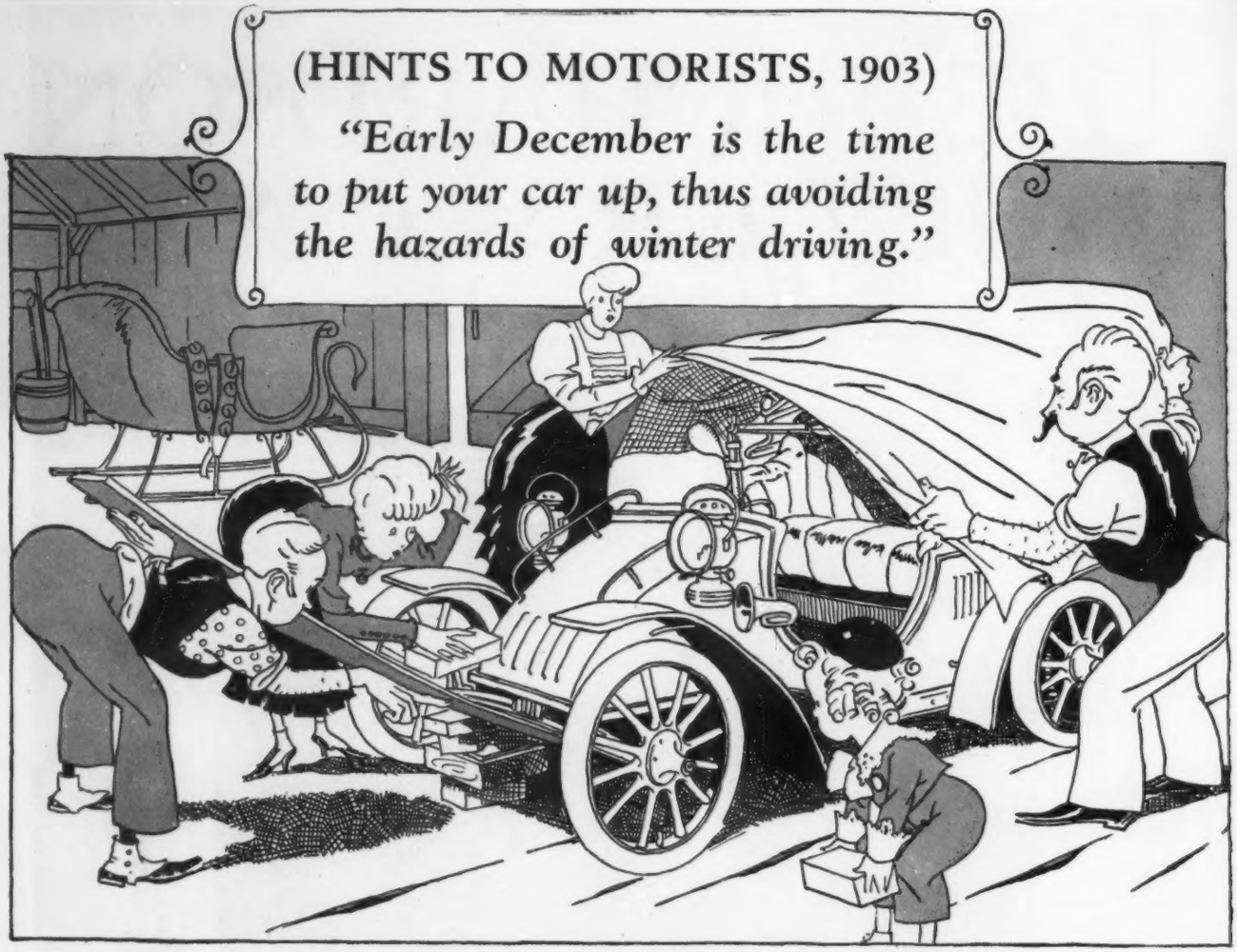
THE dictionary's definition of "Mechanical" fits Bendix 4 Brakes perfectly—one of the reasons why leading engineers prefer them.

The Bendix 3-shoe self-energizing brake sets a new standard of braking efficiency. *It turns the momentum of the moving car into braking power.*

Mechanical—dependable—that is why thousands and thousands of new cars, coaches, trucks, are being put in service each month equipped with Bendix 4-Wheel Brakes.

BENDIX BRAKE COMPANY
General Office and Plant: South Bend, Ind.
Division of Bendix Corporation, Chicago

BENDIX 4 BRAKES
MECHANICAL **FOR SAFETY**



TODAY, putting the car "up for the winter" is as much of a chestnut as hand-cranking—but icy roads still give wheels a tough battle.

Slippery stretches; sudden skids that slap the spokes against curb or frozen rut. These are still wintry risks—except for the drivers who are wise enough to ride on Budd-Michelins.

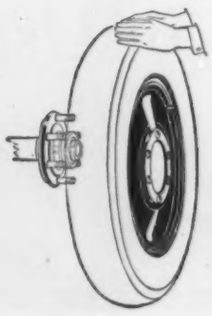
Wood splinters—steel can't! So Budd-Michelin Wheels stand the pounding. When one does bend—and the blow it takes to do it would smash a wooden wheel!—it isn't necessary to call the tow car. There is the fifth Budd-Michelin to roll home on, and it only costs $3 to have the bent wheel straightened out again.

This extra measure of winter safety is a timely point to stress. It is helping the men who sell Budd-Michelin equipped cars.

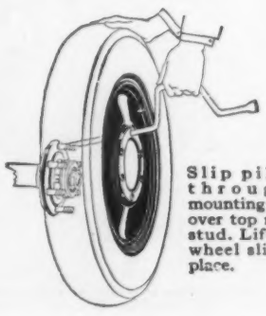
BUDD

WHEEL COMPANY . . . *Detroit*

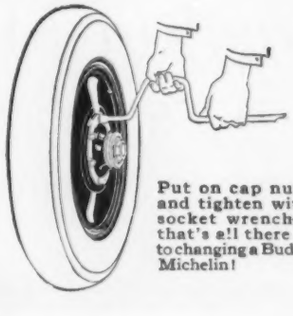
Budd Service Stations in all principal cities—parts and service for wheels of every type.



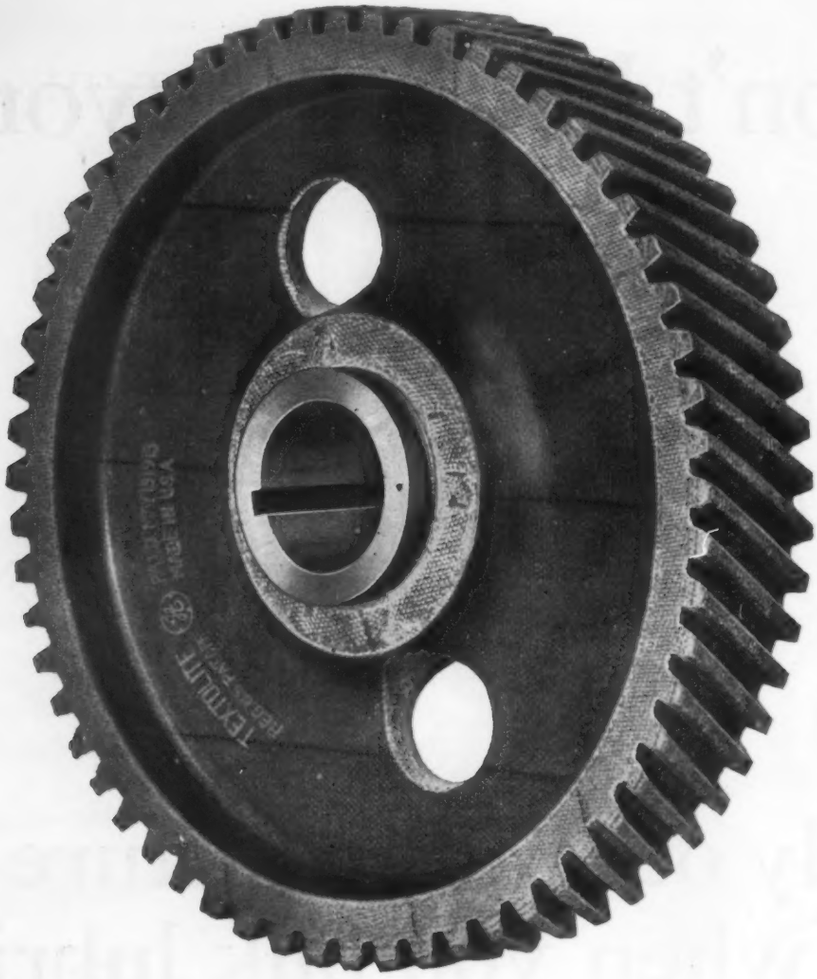
To put on a Budd-Michelin Wheel, set brakes and place wheel in position before the mounting studs.



Slip pilot bar through top mounting hole and over top mounting stud. Lift up and wheel slides into place.



Put on cap nuts and tighten with socket wrench—that's all there is to changing a Budd-Michelin!



Textolite Timing Gears

The quietness and resilience of Textolite timing gears are not obtained at the cost of a short life.

In a very large fleet of taxis, all of which are equipped with Textolite timing gears, not a single replacement has yet been made except where the camshaft bearing seized or the water pump froze.

Some of these taxicabs have been driven a total of 150,000 miles.

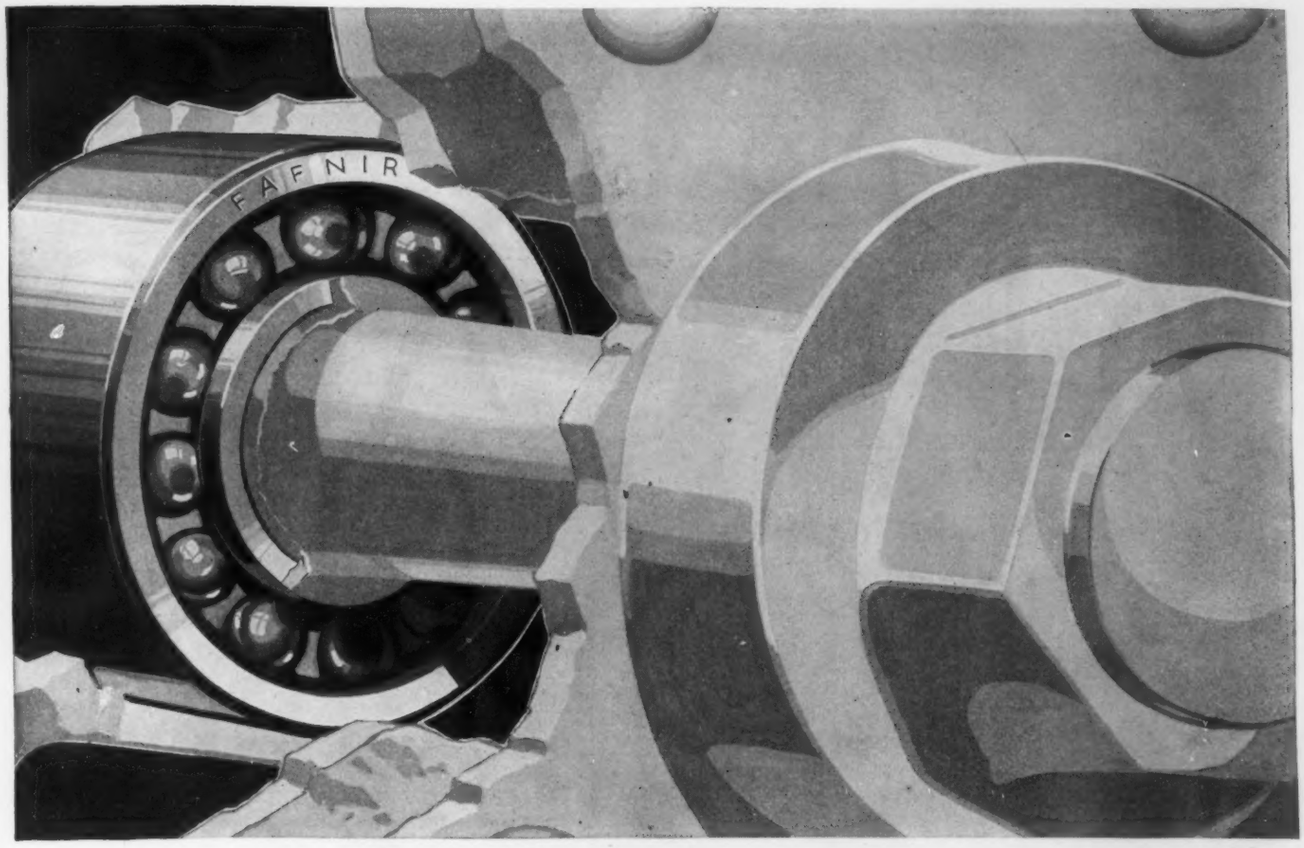
When Textolite rep'acement gears are desired, complete details and the name of the nearest distributor can be obtained from:

John C. Hoof & Company
162 N. Franklin St., Chicago, Ill.

830-25

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES



Here, shock and thrust call for ball bearings

REAR wheel bearings are required to support more than half the weight of vehicle and passengers—to resist the severe shocks incident to travel over poor roads —to withstand the end thrust encountered turning corners, crowned roads, etc.

What better place to install ball bearings, with their greater shock and overload carrying capacity?

THE FAFNIR BEARING COMPANY, NEW BRITAIN, CONN.

Makers of high grade ball bearings—the most complete line of types and sizes in America

FAFNIR
BALL BEARINGS

Molybdenum Steel throughout IN BOTH RINGS AND BALLS

Since 1908 Oakland has chosen HYATT *Quiet Bearings!*

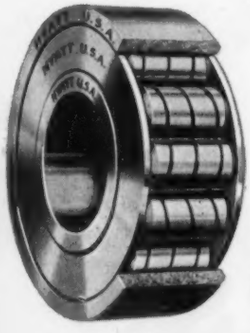
"Value," Oakland says, "is what you get for what you pay, and here in the All-American Six is the most in a motor car that an equal amount of money ever bought."

Important among those features which contribute to the value of the Oakland All-American Six—are Hyatt Quiet Roller Bearings.

It is only natural that Oakland should select Hyatt Bearings for the car that was built to meet every demand of American performance—because Oakland has used Hyatts since 1908!

AUTHORIZED UNITED MOTORS SERVICE HYATT ROLLER BEARINGS

The Sign of Official Hyatt Service



HYATT ROLLER BEARING COMPANY
NEWARK · DETROIT · CHICAGO · PITTSBURGH

HYATT

QUIET ROLLER BEARINGS

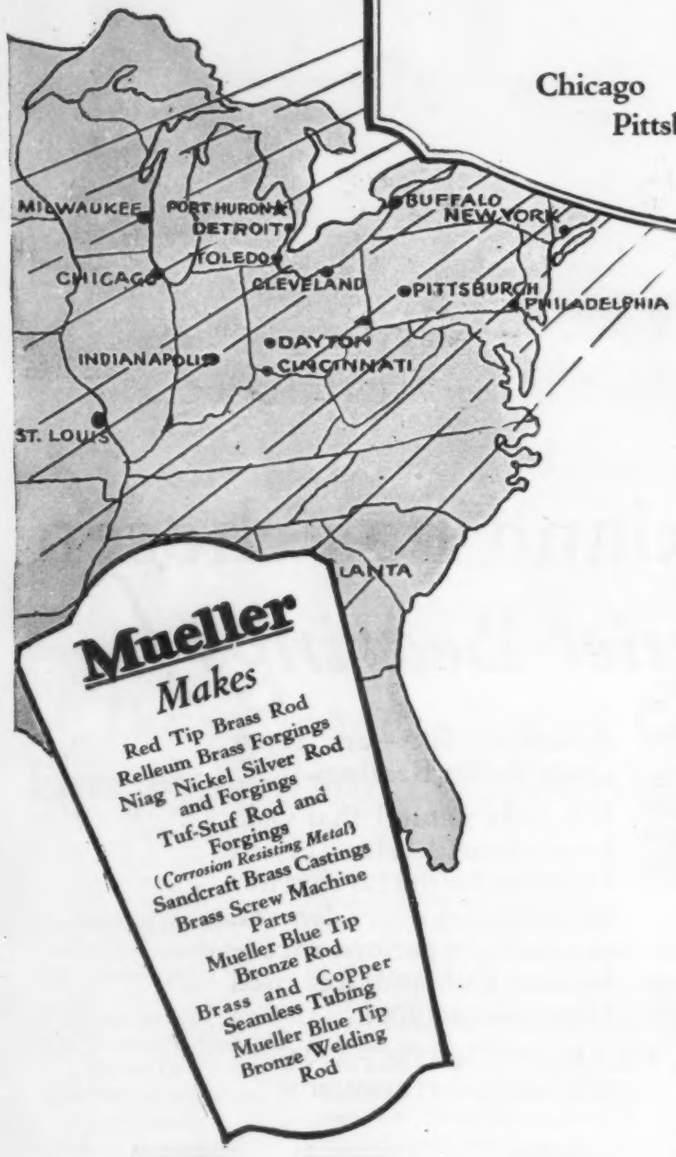
Mueller of Port Huron thru its large plant and warehouses gives exceptional service to Industry.

Offices:

New York	Flint	Buffalo
Detroit	Portland	Milwaukee
Dayton	Pittsburgh	Minneapolis
Seattle	Chicago	Indianapolis
Philadelphia	New Orleans	St. Louis
Cleveland	Spokane	

Warehouses:

Chicago St. Louis Dayton
Pittsburgh New Orleans



Mueller

Makes

Red Tip Brass Rod
Relleum Brass Forgings
Niag Nickel Silver Rod and Forgings
Tuf-Stuf Rod and Forgings
(*Corrosion Resisting Metal*)
Sandcraft Brass Castings
Brass Screw Machine Parts
Mueller Blue Tip Bronze Rod
Brass and Copper Seamless Tubing
Mueller Blue Tip Bronze Welding Rod

THE Mueller organization is nation-wide. Representatives are located in your territory. These men are competent — know the copper and brass business.

The Mueller plant and Mueller warehouses are so situated that deliveries are made promptly.

Take advantage of this prompt service.

Mueller Brass Co.
PORT HURON - - MICHIGAN
DETROIT DISTRICT

Offices:

New York	Philadelphia	Pittsburgh	Buffalo
Detroit	Cleveland	Chicago	Milwaukee
Dayton	Flint	New Orleans	Minneapolis
Seattle	Portland	Spokane	Indianapolis
St. Louis			

Warehouses:

Chicago St. Louis Dayton Pittsburgh New Orleans

Mueller Brass

THREE GENERATIONS OF BRASS MAKING

Applicants for Membership

The applications for membership received between Oct. 15 and Nov. 15, 1927, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

ACKERMAN, ERNEST E., general manager, Liggett Spring & Axle Co., *Monongahela, Pa.*

ALDEEN, G. W., general superintendent, National Lock Co., *Rockford, Ill.*

ALEXANDER, HECTOR, complaints and special service, Uppercu-Cadillac Co., *New York City.*

ALLEN, RUSSELL E., superintendent, Fay & Bowen Engine Co., *Geneva, N. Y.*

ANDERSON, RALPH F., estimator and engineer, A. & J. Iron Works, *Chicago.*

AUDET, A. N., president and general manager, Audet Mfg. Corporation, *Williamsport, Pa.*

AVERILL, LAYTON W., service representative, Dodge Bros., Inc., *Detroit.*

BALLASH, JOSEPH L., production manager, Sterling Grinding Wheel Co., *Tiffin, Ohio.*

BARR, MAJOR ROBERT SHERMAN, U. S. A., Ordnance Department, *Cincinnati.*

BATTLES, WALTER E., assistant manager of motorcoach body production, International Motor Co., *Allentown, Pa.*

BERRY, E. W., master mechanic and chief electrician, Benguet Consolidated Mining Co., *Baguio Benguet, P. I.*

BLOSS, ERNEST K., assistant electrical engineer, Boston & Maine Railroad, *North Billerica, Mass.*

BOOR, F. H., engineer, Fairfield Mfg. Co., *Lafayette, Ind.*

BOOTES, L. C., secretary and purchasing agent, Frost Gear & Forge Co., *Jackson, Mich.*

BOSHEA, HERBERT V., assistant superintendent, Chrysler Corporation, *Newcastle, Ind.*

BRANCH, HARRY C., technical service engineer, Leece-Neville Co., *Cleveland.*

BURCH, HUGH WHITE, service superintendent, White Co., *Jersey City, N. J.*

CALHOUN, WILLIAM M., pilot and chief mechanic, Colorado Airways, Inc., *Denver.*

CAMPBELL, WALLACE R., vice-president and treasurer, Ford Motor Co. of Canada, Ltd., *Ford, Ont., Canada.*

CHRISTENSEN, LINCOLN, assistant master mechanic, Cranford & Locher, Inc., *Brooklyn, N. Y.*

CLARK, A. B., president, F. R. V. Motor Co., Inc., *New York City.*

CLAUS, CARL, mechanical engineer, Bound Brook Oil-less Bearing Co., *Bound Brook, N. J.*

CONKLIN, G. HOWARD, engineer, A C Spark Plug Co., *Flint, Mich.*

CRANE, CHARLES A., JR., works manager, Templeton, Kenly & Co., Ltd., *Chicago.*

CRUMP, ALBERT V., body engineer, Paige-Detroit Motor Car Co., *Detroit.*

DAVIS, GILBERT W., standards department, Durant Motors of New Jersey, *Elizabeth, N. J.*

DEBISHOP, ARTHUR, mechanical draftsman, Edward Miller Co., *Meriden, Conn.*

EGER, KARL A., assistant engineer, Leece-Neville Co., *Cleveland.*

FINCH, LIEUT. VOLNEY C., U. S. N., *San Diego, Cal.*

GATY, JOHN P., mechanical engineer, Premier Laboratory Co., Inc. *New York City.*

GFRORER, J. F., general manager of service, Hudson Motor Car Co. of New York, Inc., *New York City.*

GOTFREDSON, ROBERT B., vice-president, Gotfredson Truck Corporation, *Detroit.*

GRAHAM, JOHN R., service manager, Thornton-Fuller Automobile Co., *Philadelphia.*

HARTER, CLIFFORD D., engineer, General Motors Proving Grounds, *Milford, Mich.*

HAROLD, RITCH, chief clerk, engineering department, Servel Mfg. Co., *Evansville, Ind.*

HAWKINS, WILFORD J., vice-president, American Machine & Foundry Co., *Brooklyn, N. Y.*

HEINRICH, LOUIS J., service manager, Autocar Sales & Service Co., Inc., *New York City.*

HOOVER, R. W., division superintendent, Mid-Continent Petroleum Corporation, *St. Louis.*

HOWELL, N. D., sales engineer, New Departure Mfg. Co., *Bristol, Conn.*

HOYT, EARL J., factory representative for sales and service, Skagit Steel & Iron Works, *Sedro-Woolley, Wash.*

HUDSON, FRANK W., chassis designer, General Motors Truck Co., *Pontiac, Mich.*

HUF, HARRY F., senior research chemist, Atlantic Refining Co., *Philadelphia.*

JENKINS, LAWRENCE K., chief draftsman, Gramm Motors, Inc., *Delphos, Ohio.*

JEWELL, GEORGE A., production manager, Hackney Bros. Body Co., *Wilson, N. C.*

JOHNSON, H. W., president, H. W. Johnson & Co., Inc., *Boston.*

KENNEDY, J. P., JR., sales engineer, Georgia Power Co., *Atlanta, Ga.*

LANGHAM, E. J., JR., truck and motorcoach tire sales, Kelly-Springfield Tire Co., *New York City.*

LEDERER, E. R., vice-president and director, Texas Pacific Coal & Oil Co., *Fort Worth, Tex.*

LEE, JOHN G., aeronautical engineer, Fairchild Airplane Mfg. Corporation, *Farmingdale, N. Y.*

LEEDS, NORMAN, JR., sales engineer, Raybestos Co., *Bridgeport, Conn.*

LIENESCH, CHARLES F., associate chemist and assistant engineer of standards, Union Oil Co. of California, *Los Angeles.*

LINEK, JOSEPH, owner of engine rebuilding and machine shop, *Maspeth, N. Y.*

MAISE, HERMAN C., vice-president and general manager, Briggs Mfg. Co., *Detroit.*

MALMGREN, SWEN, draftsman, International Motor Co., *New Brunswick, N. J.*

MAYER, F. WARD, purchasing agent, Federal Water Service Corporation, *New York City.*

MCMINN, W. W., vice-president and treasurer, Orange Roller Bearing Co., *Orange, N. J.*

MOTZ, GUY W., Western advertising representative, Society of Automotive Engineers, Inc., *New York City.*

MUNN, M. D., repair service engineer, White Co., *Cleveland.*

NELAN, JAMES R., superintendent of shops, Los Angeles County Road Department, *Los Angeles.*

NEVIN, EDWARD, president, Nevin Truck & Bus Mfg. Co., *Brooklyn, N. Y.*

OLMSTED, C. E., vice-president, California Petroleum Corporation, *Los Angeles.*

ORCUTT, H. F. L., engineer, Gear Grinding Co., Ltd., *Handsworth, Birmingham, England.*

PARKER, PHILIP S., engineer, Buxwood, *Sydney, New South Wales, Australia.*

PEIRCE, W. M., metallurgist, research division, New Jersey Zinc Co., *Palmerton, Pa.*

PHILLIPS, CARL M., experimental body engineer, Hayes-Hunt Corporation, *Elizabeth, N. J.*

PLATT, A. R., owner, automobile repair shop, *Pittsburgh.*

POEHLE, HERBERT F., chemical engineer, U. S. Rubber Co., *Detroit.*

REED, N. C., district sales manager, Wheeling Steel Corporation, *Wheeling, W. Va.*

RICHTER, CALVIN P., metallurgist, Central Alloy Steel Corporation, *Massillon, Ohio.*

RICHTER, JOHN A., vice-president, Groov-Pin Corporation, 45-22 38th St., *Long Island City, N. Y.*

RINEHART, H. M., mechanical engineering student, Oregon State College, *Corvallis, Ore.*

ROSENBAUM, WALTER, executive, Rosenbaum Co., *Pittsburgh.*

RUMSEY, VERNE P., general inspector, Chrysler Corporation, *Highland Park, Mich.*

SCHLIEDER, V. W., vice-president and treasurer, Schlieder Mfg. Co., *Milford, Mich.*

SEARS, WILLIAM A., instructor of automotive mechanics, Lane Technical High School, *Chicago.*

SHOEMAKER, LIEUT-COM. JAMES MARSHALL, U. S. N., head of engine section, bureau of aeronautics, Navy Department, *City of Washington.*

SILLCOX, LEWIS K., assistant to president, New York Air Brake Co., *New York City.*

SPARKS, BAYARD P., manager of technical department, Buick Motor Co., New York Branch, *New York City.*

STEPHENSON, W. B., president, Aelta Electric Co., *Marion, Ind.*

STEWART, PETER, test engineer, Hyatt bearing division, General Motors Corporation, *Harrison, N. J.*

STORZ, ARTHUR C., vice-president and general manager, Storz Western Auto Supply Co., *Omaha, Neb.*

STOUT, GEORGE H., assistant sales manager, Reo Motor Car Co. of New York, *New York City.*

SUPY, M. FORD, district service manager, Studebaker Corporation of America, *South Bend, Ind.*

TEJADA, J. DE D., technical translator, San Ignacio No. 50, *Havana, Cuba.*

TURNQUIST, EDWARD, tool engineer, Delco-Remy Corporation, *Anderson, Ind.*

VAN DEUSEN, CAPT. E. S., U. S. A. Quartermaster Corps, Camp Holabird, *Baltimore.*

VAN SANDWYK, M. C., works manager and service manager, Atkinson's Motor Garages, Ltd., *Bloemfontein, South Africa.*

VAN WAGNES, ALTON J., lubrication engineer, Vacuum Oil Co., *Detroit.*

WALDRON, H. E., draftsman and checker, Lincoln division of Ford Motor Co., *Detroit.*

WATSON, LIEUT. LESTER F., U. S. A., third motor repair battalion, Camp Normoyle, *San Antonio, Tex.*

WEISS, ADRIAN E., factory manager, Superior Die Casting Co., *Cleveland.*

WHITE, A. BLYTH, inspector of automotive equipment, Bell Telephone Co. of Canada, *Montreal, Que., Canada.*

ZEDER, THOMAS B., sales engineer, J. W. Murray Mfg. Co., *Detroit.*

Personal Notes of the Members
Continued

issue of THE JOURNAL, he was for 3 years chief engineer of the Commerce Motor Truck Co. prior to its consolidation and change of name to the Relay Motors Corporation.

Mr. Kincaid's business career, which began in 1904, has been varied and interesting. He worked for the Washington Steel & Ordnance Co. for 6 years as engineer, and has held positions with the S. K. Mfg. Co., the Ford Motor Co., and the Bond Realty Co. In 1923 he went with the Commerce Motor Truck Co., and became chief engineer in 1924.

Since 1925, when he was elected to Member grade, Mr. Kincaid has been a member of the Society and a member of the Detroit Section.

Thomas H. Huff, formerly president of Huff, Daland & Co., is now president of Huff Airplanes, Inc., a new organization located at Perth Amboy, N. J.

Since his graduation from the Massachusetts Institute of Technology in 1915, Mr. Huff has been engaged in the field of aeronautics, first as instructor in that subject at the Massachusetts Institute of Technology, and successively as assistant aeronautical engineer with the Sturtevant Aeroplane Co., chief engineer of the Standard Aeronautic Corporation, chief of design and experimental section of the Naval Aircraft Factory, and finally as president of Huff, Daland & Co. in 1920.

He was elected to Junior Member grade in the Society in 1917, and was transferred in 1920 to Member grade.

George P. Anderson has been appointed director of sales engineering for Dodge Bros., Inc., Detroit. Previously he was transportation engineer for Graham Bros., also of that city.

Justin D. Anderson, who for the last 12 years has been vice-president of the Fisk Rubber Co., Chicopee Falls, Mass., has severed his connection with this company. No announcement has been made of his future plans.

Walter D. Appel, formerly on the staff of the regional director for Europe of the General Motors Export Co., has been appointed chief engineer of Vauxhall Motors, Ltd., Luton, Bedfordshire, England.

Walter H. Bailey has opened an office at 122 William Street, New York City, for the purpose of placing automobile insurance. He will give special attention to fleet, dealers' and garage business, as well as that of individual owners of cars and motor-trucks. He was formerly an adjuster for the Royal Indemnity Co., also of New York City.

Edwin L. Bernhart, who until recently was production and mechanical engineer for the Commercial Truck Co., Philadelphia, has established the Keystone Garage, Erdenheim, Pa., and is conducting a general service business.

H. G. Blakeslee, previously sales manager for the Magneto Service Station, Atlanta, Ga., has been appointed Southern district representative for the Zenith-Detroit Corporation, Detroit. He will continue to make his headquarters in Atlanta.

A. D. Chandler, who formerly was sales manager for the Beaver Mfg. Co., Milwaukee, has become associated with the Continental Motors Corporation, Detroit. In his new connection he holds the position of sales engineer in the industrial department and is located in Muskegon, Mich.

K. R. Charlton now maintains an office as manufacturers' sales agent in Holyoke, Mass. His prior business connection was treasurer of the L. A. W. Acceptance Corporation, also of Holyoke.

M. M. Cunningham is now service engineer for the Bendix Brake Co., South Bend, Ind. He received his technical training at the University of Michigan, Ann Arbor, Mich.

H. T. Daniels, who was previously manager and buyer for the S. W. Grove Motor Supply Co., Wichita, Kan., has accepted a position with the Diamond T Motor Truck Co., Chicago. In his new connection he has charge of the com-

(*Continued on p.* 20)

First decide what you want a spring control to do!

IF you were to make a graph showing the action of a Hassler by pounds of resistance, you would have to plot an *ascending* curve.

Do the same for certain other well-known spring control devices, and your curve will be *descending*.

That is, Hassler action is cumulative. Exceedingly gentle at the beginning of the rebound, its hold tightens as the spring goes up.

The other type of action is diminishing. It grips and then gradually lets go.

Of the two types of rebound resistance, which is the more desirable—the cumulative, as in the Hassler, or the diminishing, as in other devices?

Consider this question in the light of current riding conditions.

From seventy to ninety per cent of today's driving is done on improved roads—concrete, asphalt, macadam, brick, Tarvia.

Every such road is full of countless tiny irregularities, so small you scarcely see them in the daytime, though bright lights and heavy shadows reveal them plainly at night.

Small as these irregularities are, they are sufficient to set today's responsive springs into motion. They therefore become of great importance as the cause of "galloping"—the last great obstacle to complete riding comfort.

The exceedingly rapid succession in which they occur naturally calls for constant action of the springs.

What happens, then, when rebound is abruptly checked at its very beginning?

Spring resiliency is reduced as a result of the compression in which the spring is held. A desirable quality carefully built into today's cars is therefore momentarily lost.

And the springs themselves are so much the less prepared to absorb the shock from an immediately succeeding bump. With the multitude of tiny hollows and depressions in every good road, this sacrifice of resiliency must be practically constant.

To overcome "galloping," and at the same time to preserve the greatest possible resiliency of today's softer springs, a spring control device must permit some play at all times.

From seventy to ninety per cent of today's driving is done on roads like this—full of countless tiny irregularities coming rapidly in succession. These are the cause of "galloping"

This, naturally, is best effected when the action is cumulative, as in the Hassler.

The Hassler does not grip. Its action is exactly like that of the car spring itself—the greater the pressure, the greater the resistance.

The Hassler is water-tight. Its internal mechanism is sealed against destructive dirt, mud, grit and slush. And every Hassler is equipped with an Alemite or Zerk fitting for lubrication with Alemite chassis lubricant.

Thus sealed and lubricated, the Hassler insures uninterrupted service for the life of your car, freedom under all conditions from annoying noises, and permanent protection of that precise adjustment which is absolutely essential for perfect spring action and control. No readjustment is ever necessary.

We want you to know what the new Hasslers will do for your car.

We are therefore happy to place at your command the largest factory in the world devoted exclusively to the production of spring control devices. We will help you work out your individual problems.

Phone or write Indianapolis headquarters or our Detroit offices.

HASSLER MANUFACTURING CO., Inc.
INDIANAPOLIS, U. S. A.

HASSLER DETROIT CO.
2-219 GENERAL MOTORS BLDG.

Personal Notes of the Members

Continued

pany's service shop in Wichita, which is known as the Storage Service Co.

Denver Rock Drill Mfg. Co., Denver, an Affiliate Member of the Society, has consolidated with the Gardner Governor Co., Quincy, Ill., and will hereafter be known as the Gardner-Denver Co. with headquarters in Quincy.

E. F. Dickieson, Jr., has received the appointment of designing and sales engineer for the Hershey Mfg. Co., Chicago. He will make his headquarters in the General Motors Building, Detroit. Prior to this connection Mr. Dickieson was manager of the Detroit office of the Wilkening Mfg. Co., Philadelphia.

James L. Endicott recently became chief engineer of the Elgin Oil Burner Corporation, City of Washington. Previously he was engineer and plant manager of the Diatomaceous Products Co., Inc., also of that city.

Henri A. Franchimont, who was aeronautical engineer for the Atlantic Aircraft Corporation, Hasbrouck Heights, N. J., has become associated with the Fairchild Airplane Mfg. Corporation, Farmingdale, N. Y. He is acting in the capacity of aeronautical engineer and giving particular attention to mathematical designing.

Victor R. Gage, professor of experimental engineering in Sibley School of Mechanical Engineering, Cornell University, Ithaca, N. Y., has been granted a sabbatical year's leave of absence and is acting as engineer for the Western Electric Co., Inc., Chicago.

Ralph R. Graichen has become chief engineer of the Halpin Development Co., Cincinnati, manufacturers of all-metal aircraft. His prior business connection was with the Ford Motor Co., Dearborn, Mich., as aeronautical engineer.

Leo V. Grogan is performing the duties of service manager for the Automobile Sales Co., Memphis, Tenn. He was formerly affiliated with the Studebaker Sales Co., of Memphis as service manager, secretary and treasurer.

Kenneth A. Harmon is acting as engineer for the Wico Electric Co., West Springfield, Mass. He was previously salesman for the Orr Motor Co., also of that city.

H. C. Harper assumed the duties of manager of the technical division of the General Motors Products of Canada, Ltd., Winnipeg, Manitoba, on Nov. 15. He was formerly in charge of investigation and settlement of complaints in the technical division of the General Motors of Canada, Ltd., Oshawa, Ont.

Fred W. Heckert, who was until recently attached to the chief-installation and engine-liaison-unit of the powerplant branch of the engineering section of the Materiel Division of the Air Corps, at McCook Field, Dayton. Ohio, is now sales engineer for the Cincinnati Ball Crank Co., Cincinnati. Since Nov. 1 his headquarters have been at Dayton, where he represents the Balcrank products of the company.

L. S. Hobbs has become affiliated with the Pratt & Whitney Aircraft Co., Hartford, Conn. His previous position was engineer for the Stromberg Motor Devices Co., Chicago.

Linley E. Hutchens, who was formerly manager of the lubricating department of the Cities Service Oil Co., Tulsa, Okla., has organized the Fred Wood Oil Co., of that city, for the marketing of petroleum products.

Elmer P. Jasper has accepted a position as chief draftsman and marine layout man for the Chris Smith & Sons Boat Works, Algonac, Mich.

Harold Jay, who for the last 8 years has been associated with the Acklin Stamping Co., Toledo, in a sales capacity, has been appointed district manager of the Detroit office, which the company recently opened in the General Motors Building.

Max L. Jeffrey has become works manager of the National Acme Co., Cleveland. He was affiliated for several years with

(*Continued on p.* 22)

Personal Notes of the Members
Continued

the White Motor Co., of that city, in the capacity of assistant production manager, and more recently with the Continental Motors Corporation.

W. O. Kennington is now general manager of the Vauxhall Motors, Ltd., Luton, Bedfordshire, England. Some months ago he was appointed regional engineer for Europe by the General Motors Export Co.

Albert E. Koffer has severed his connection with the Oakland Motor Car Co., Pontiac, Mich., where he held the position of chief draftsman. No announcement has been made regarding his future plans.

C. F. Kopatschek, who was formerly diemaker for the Motor Products Co., Detroit, is now die designer for the Briggs Mfg. Co., also of Detroit.

Benjamin L. Koppin is now affiliated with the Ford Motor Co., Dearborn, Mich., in the capacity of layout draftsman, working on trucks and tractors. He was previously engineer in full charge for the Sauzedde Corporation, Detroit, and more recently layout draftsman for the Continental Motors Corporation, also of that city.

A. S. Krotz resigned his position as assistant service manager for the Stutz Motor Car Co., Indianapolis, and has become associated with the General Motors Export Co., New York City.

Franklin T. Kurt, who received his technical training at the Massachusetts Institute of Technology, Cambridge, has become assistant manager and pilot for the Dennison Aircraft Corporation, Atlantic, Mass.

A. G. Laas has accepted a position with the Studebaker Corporation of America, South Bend, Ind. Previously he was service representative for the Locomobile Co. of America, Bridgeport, Conn.

Charles F. Loew has become associated with the Fay & Bowen Engine Co., Geneva, N. Y. Prior to establishing this connection he was sales engineer for the American Monorail Co., Cleveland.

J. Mackenzie Miller has been appointed engineer for the Stromberg Motor Devices Co., Chicago, and will be engaged chiefly in the development of aviation-engine carbureters. His prior connection was associate mechanical engineer in the materiel division of the Air Corps at Wright Field, Dayton, Ohio.

Walter Marschner is now aeronautical engineer for the Glenn L. Martin Co., Cleveland. He was previously mechanical engineer for the Atlantic Aircraft Corporation, Hasbrouck Heights, N. J.

Lewis K. Marshall, who was formerly head of the technical data section and assistant secretary of the new devices committee of the General Motors Corporation Research Laboratories, Detroit, is now affiliated with the engineering department of the Buick Motor Co., Flint, Mich.

J. Hampton McClelland, until recently sales engineer for the Houde Engineering Corporation, Detroit, has made a new business connection. He now holds a similar position in the Torridaire division of the American Metal Products Co., also of Detroit.

Charles Meder has opened an office at 1834 Broadway, New York City, for the purpose of acting as direct factory representative for storage-battery and automotive material and equipment. He was previously president and treasurer of the United Battery Separator Co., of the above address.

Nathan A. Middleton announces the formation of a partnership doing business under the title of Middleton, Eden & Co., with offices in the Rockefeller Building, Cleveland. The purpose of this organization is to act as manufacturers' representative and give engineering and financial consultation in connection with mergers, reorganizations, and related activities. Prior to engaging in this undertaking, Mr. Middleton was president of the Ohio Body Co., also of Cleveland.

(*Continued on p.* 24)

Personal Notes of the Members
Continued

John W. Mills has become associated with the Fejes Patents Syndicate, Ltd., Westminster, England, with the title of general manager.

Harry G. Miner, of the General Motors Truck Co., has been transferred from the Yellow Coach service division in New York City to the engineering specifications department of the company in Pontiac, Mich.

Bruce G. Mortimer, until recently special service representative for Durant Motors of Canada, Ltd., Toronto, has become service manager for the Toronto Durant Co., also of that city.

Joe M. Newman, who has been taking the apprentice course in the Olds Motor Works, Lansing, Mich., has been made assistant superintendent of construction for this company.

Leonard V. Newton has become mechanical engineer in charge of transportation for the Byllesby Engineering & Management Corporation, Chicago. He was previously general manager of the motor transport division of the Pure Oil Co., also of Chicago.

Yoshio Ogawa, who was formerly associated with the I. Sekine Co., Inc., and the Uppercu-Cadillac Corporation, both of New York City, on Nov. 1 assumed his new duties as representative for the General Motors Export Co., also of New York City.

Vernon Peterson is acting as factory representative in the Denver territory for the Simplicity Mfg. Co., Port Washington, Wis., and the Cornwell Quality Tools Co., Mogadore, Ohio.

E. N. Rahusen, who was engineer in charge of analysis of design for the Gnome & Rhone Aero Engine Co., Paris, has accepted a position with Thomassen Machine & Motorenfabriek, De Steeg, Holland.

Paul Ramsey recently accepted a position in the engineering department of the American Car & Foundry Motors Co., Detroit. Previously he was body and sheet-metal draftsman for the Olds Motor Works, Lansing, Mich.

John D. Ristine is now affiliated with the Arco Co., Cleveland. He was formerly associated with the Prest-O-Lite Storage Battery Co., Indianapolis.

R. M. Sanders, who resigned as sales engineer for the American Armour Co., New York City, has received the appointment of factory manager and chief engineer of the Automatic Drive & Transmission Corporation, Gloucester City, N. J.

B. Russell Shaw has organized a company for the construction of airports and consultation on their equipment, operating under the title of B. Russell Shaw & Co., with offices in the Arcade Building, St. Louis. Prior to engaging in this business he was airport engineer for the Stout Air Services, Inc., Detroit.

L. C. Shinn, who for several years was head of the metal-trades department of the Arsenal Technical Schools, Indianapolis, and more recently affiliated with the Keyless Lock Co., also of that city, is now field engineer for the Charles E. Bedaux Co., Chicago.

Mac Short, formerly instructor in the aeronautical department of the Massachusetts Institute of Technology, Cambridge, became associated with the Stearman Aircraft Co. in June as vice-president and chief engineer. Recently the company, desiring a more central location, moved its factory and general offices from Venice, Cal., to Wichita, Kan.

Herbert Sierk has removed his office from St. Louis to Houston, Tex., where he conducts a sales agency.

J. A. Silberman, who until recently was treasurer and engineer for the Chevron Motor Corporation, Jersey City, N. J., has become owner of the Chevron Motor Corporation, in New York City.

(*Concluded on p.* 26)

Personal Notes of the Members
Concluded

James H. Skelly has accepted a position as automotive engineer for the Indian Motocycle Co., Springfield, Mass. For a number of years he was tool designer for the Lycoming Mfg. Co., Williamsport, Pa.

Herbert A. Stein was recently made assistant sales manager for the Hudson-Essex Motor Co., m.b.H., Berlin-Spandau, Germany. He was previously commercial-car salesman for Bishop, McCormick & Bishop, Brooklyn, N. Y.

George Tasman, chief engineer and designer for Locke & Co., has been transferred from New York City to the home office in Rochester, N. Y.

Lieut. Guy D. Townsend, U. S. N., who was previously superintendent of the aeronautical engine laboratory at the Naval Aircraft Factory, Philadelphia, has been assigned to the VT-9S of the Aircraft Squadrons Scouting Fleet, and is acting in the capacity of executive officer.

M. A. Trisler has severed his connection with the General Motors Corporation Research Laboratories, Detroit, where he was research engineer. No announcement has been made regarding his future plans.

J. Parker Van Zandt recently was made president and general manager of Scenic Airways, Inc., Grand Canyon, Ariz., which is engaged in commercial aviation. Previously he was in charge of flying for the Scout Air Services, Inc., Detroit.

Ernest K. von Brand has accepted the position of experimental engineer for the Fedders Mfg. Co., Buffalo.

Carl Voorhies is now engineering representative in production for the Studebaker Corporation of America and has removed his headquarters from the main factory in South Bend, Ind., to Plant No. 10, Detroit.

Robert C. Wallace, who received his technical training at the Massachusetts Institute of Technology, Cambridge, has accepted a position as mechanic in the service department of the Stutz Motor Car Co. of America, Indianapolis.

Earl F. Ward, until recently attached to the Air Mail Service in the capacity of pilot, operating from Cleveland, now holds a similar position with the National Air Transport, Inc. His headquarters will be at the Cleveland Airport, located in that city.

W. C. Ware, who was formerly president of the Fay & Bowen Engine Co., Geneva, N. Y., has been elected vice-president of the Paragon Gear Works, Taunton, Mass.

Jay L. Warner, of the Mack-International Motor Truck Corporation, has been appointed sales manager of the Tacoma, Wash., district. He was previously division representative at Seattle.

O. W. Warner has opened a general repair and service station to be known as the South Side Garage, Kalamazoo, Mich.

George E. Weir, who was until recently sales engineer for the Belden Mfg. Co., Chicago, is now affiliated with the Gemmer Mfg. Co., Detroit, in the same capacity.

John Whyte has been made chief engineer of the Warner Electric Brake Corporation, Beloit, Wis.

George L. Willman, previously identified with the Dartnell Corporation, Chicago, as merchandising and advertising counsel, is now executive in charge of automatic advertising for Critchfield & Co., also of that city.

Robert S. Winter has become production engineer for the Detroit Aircraft Engine Corporation, Detroit. He formerly held a similar position with the Rickenbacker Motor Co. of the same city.

Clayton E. Wyrick, who for a number of years was engaged in business for himself as mechanical engineer and patent attorney with office in Detroit, has been appointed technical engineer for the Gairing Tool Co., also of that city.

Paul G. Zimmermann has resigned as vice-president and manager of manufacturing of the Sea Sled Corporation, West Mystic, Conn., and recently organized the Paul G. Zimmermann Metal Aircraft, Mystic, Conn. This company will design and manufacture aircraft and aircraft parts, giving special attention to light alloy construction.

Notes and Reviews

This column, which is prepared by the Research Department, gives brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

The letters and numbers in brackets following the titles classify the articles into the following divisions and subdivisions.

Divisions.—**A**, Aircraft; **B**, Body; **C**, Chassis Parts; **D**, Education; **E**, Engines; **F**, Highways; **G**, Material; **H**, Miscellaneous; **I**, Motorboat; **J**, Motorcoach; **K**, Motor-Truck; **L**, Passenger-Car; and **M**, Tractor.

Subdivisions.—**1**, Design and Research; **2**, Maintenance and Service; **3**, Miscellaneous; **4**, Operation; **5**, Production; and **6**, Sales.

AIRCRAFT

Germany Revives Tail-First Machine. Published in *Flight*, Sept, 29, 1927, p. 679. [A-1]

The modern airplane which has given rise to the revival of the subject of the tail-first arrangement is the F-19, designed and built by the Focke-Wulf Co., of Bremen, Germany. Before proceeding to the actual construction of the machine, a model was tested thoroughly in the wind-tunnel at Göttingen, and an arrangement is said to have been evolved that proved stable around longitudinal, lateral and directional axes. The actual airplane has passed its preliminary test flights and the indications are said to be that the results of the Göttingen tests will be borne out. The full-scale craft also seems to confirm the wind-tunnel determination that the machine cannot be stalled. While no performance figures are available, the wind-tunnel tests indicate that the efficiency of this airplane is about the same as that of a good modern commercial craft of orthodox type.

Soaring Flight. By Wolfgang Klemperer. Published in *The Journal of the Franklin Institute*, September, 1927, p. 293. [A-1]

Now that the engine-driven airplane is assuming a serious character as an instrument of commerce, those who are interested in aviation as a sport are offered the glider as a substitute. Says the author:

> I am unable to describe by words the sublime pleasure one experiences in gliding over hills and valleys, silently, like the eagle, cruising or hovering, rising or descending at will.

Two additional missions are assigned to gliding and soaring flight. It is a supplementary experimental means for investigating problems in which the elimination of interference of a propeller slip-stream with the lift of wings, stability and control is essential and it affords, especially to the young, opportunity for acquiring aerial experience which will be of value in later training for commercial or private flying.

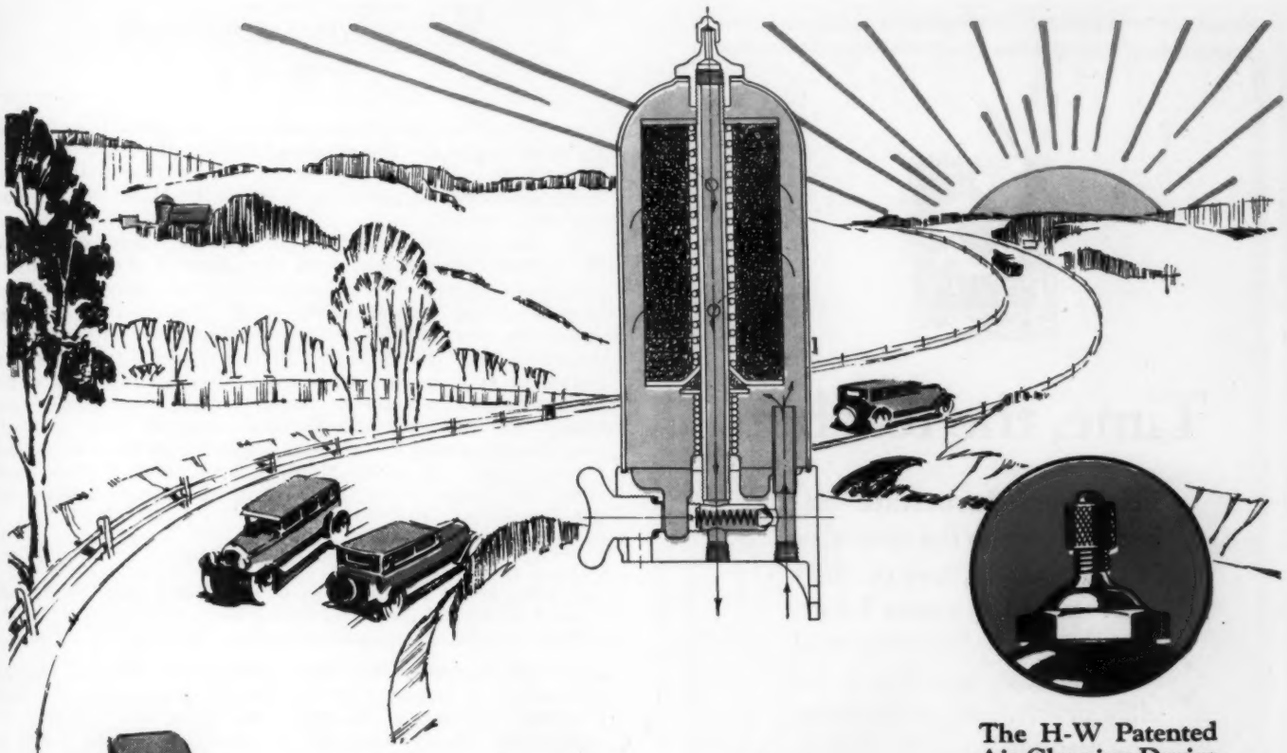
To gliding is also attached the interest of having been the first form of heavier-than-air flight, and it might, had not the internal-combustion engine been so opportunely groomed into utility, influenced profoundly the history of aviation. When gliding was resumed in Germany in 1920, it became the pupil instead of the teacher, and profited from the technical knowledge accumulated in engine-driven flight.

After tracing briefly the recent activity in soaring flight, the author expounds the principles of the two types, static and dynamic. The former consists of gliding down in a rising current of air; for the latter, energy is drawn from the irregularities in the wind movements, gusts or vertical wind-gradients, for instance. Details of the design and operation of gliders are presented in the final section of the article.

Materials for Aircraft Parts Subjected to High Temperatures. By J. B. Johnson. Preprint of paper presented before American Society of Mechanical Engineers. Published by American Society of Mechanical Engineers, New York City. 6 pp.; 11 illustrations. [A-5]

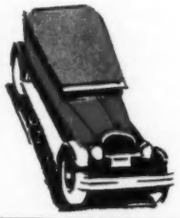
In the first or introductory part of this paper a summary is

(*Continued on p.* 30)



The H-W Patented Air Cleaning Device

Remove the nut, fit compressed air hose to the valve—and the pressure rids the filtering medium of all impurities, which are blown out of the drain opening.



The Day of Better Lubrication Has Arrived!

Another great stride in the march of mechanical progress! The H-W Filtrator has made better lubrication an accomplished fact.

The H-W Filtrator embodies these exclusive features:

1. ***Non-disintegrating filtering element.***
2. ***Automatic cleansing means.***
3. ***Solid contamination once removed can never be returned to the engine.***
4. ***Affords 100 per cent bearing protection.***
5. ***The H-W Filtrator in itself does not contribute to loss of oil pressure, but on the other hand tends to prevent pressure loss as the engine mileage is built up.***

Now a lubricant can actually be kept free of all deadly abrasives by a filter that is good for the life of the motor. Now the smooth surfaces of perfectly fitting engine parts can be effectively protected from unnecessary wear.

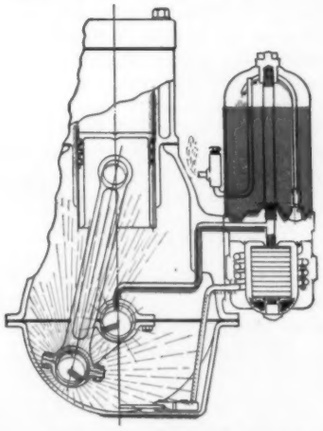
Give us the opportunity to prove the superiority of the H-W Filtrator. Our men are ready to demonstrate.

Sold by **RICH TOOL COMPANY**
Detroit, Mich.

H-W FILTRATOR

Double Engine Life with new

WATSON OIL-RITE SYSTEM



The right flow of pure oil—never too little, never too much. Only by maintaining this correct balance as well as the correct body can the engine operate at 100% efficiency. How the Watson Oil-Rite System solves this problem is one of the most interesting performances in automotive development. Let us explain.

Notes and Reviews

Continued

given of the information available on the operating conditions in those parts of the airplane engine that are heated by combustion. The second part discusses the materials now being used and includes tests made at the Materiel Division of the Air Service.

In dealing with material for cylinder-heads and pistons, the author touches briefly on the effect of certain alloys on aluminum; gives physical constants for pure metals and typical alloys, typical analyses and heat treatments; and gives the physical properties at elevated temperatures as determined at the Materiel Division partly by an investigation using test bars and partly by a study of an engine. Reference is also made to the difficulties of correctly calculating the clearance for pistons made of aluminum alloy and of maintaining the chemical stability of the piston alloys. Experiments made at the Materiel Division on high-chromium steels are reported in the part of the paper dealing with valve material.

CHASSIS PARTS

The Influence of Elasticity on Gear-Tooth Load. Published in *Mechanical Engineering*, November, 1927, p. 1228. [C-1]

This article constitutes Progress Report No. 7 of the American Society of Mechanical Engineers Special Research Committee on Strength of Gear Teeth. It presents the fourth and last of a series of studies that have been necessary to analyze the results obtained on the Lewis gear-testing machine. In general they have been studies of the dynamics of elastic bodies, although they have been specifically directed to gear-tooth load conditions. All of these studies are said to be preliminary in nature and subject to possible correction founded on the results of actual tests before they can be accepted as substantially true.

The present report deals with the influence of the rotating masses as affected by the elasticity of the shafts or other connections, and is specifically directed to the analysis of the mass conditions on the Lewis gear-testing machine. A series of tests to check these conditions was made in connection with the preparation of this report.

De L'Intérêt de L'Etude Scientifique de la Suspension. By A. Caputo. Published in *Omnia*, September, 1927, p. 231. [C-1]

Basicly the accelerometer designed by G. Puica and J. Keraval consists of a piston contained in a cylinder the axis of which is parallel to the movement to be measured. The cylinder is connected by a tube to a manometer. Cylinder, tube and manometer are filled with a liquid that cannot be compressed. Because of the mass of the piston, the variations of acceleration of the cylinder, which is connected solidly with the vehicle, give rise to variations of pressure in the liquid, and these are measured by the manometer.

Refinements made on this basis to correct various faults are described and the final instrument is said to give accurate measurements. A sample of its work is presented.

ENGINES

Efficiencies of Otto and Diesel Engines. By F. O. Ellenwood and C. T. Chwang. Preprint of paper presented before American Society of Mechanical Engineers. Published by American Society of Mechanical Engineers, New York City. 13 pp.; 14 illustrations. [E-1]

This paper gives primarily the results of calculations for the ideal Otto and Diesel engines in which the working substance is a mixture of real gases. The results are presented in the form of convenient tables and curves that can be used readily by any engineer for the determination of the efficiencies of internal-combustion engines operating under the various conditions existing today. The general method of procedure is explained fully and the necessary equations are given.

(*Continued on p. 32*)

Notes and Reviews

Continued

The authors also discuss the factors involved in the establishment of "real-mixture standards" on which to base the performance of Otto and Diesel engines, and compare the results obtained by somewhat different conceptions. The use of higher and lower heating values of the fuel in the various calculations involved is discussed, and the tables and curves for the 65 cases considered give the results for both values.

The importance of using engine efficiencies to express performance is stressed, and five illustrative examples indicate that some of the best internal-combustion engines have already been so well designed and built that they give the excellent result of engine efficiencies as high as 76 per cent.

Quelles Économies Peut-On Réaliser par L'Amélioration de la Carburation? By Léon Poincaré. Published in *La Technique Moderne*, Oct. 15, 1927, p. 648. [E-1]

One of the methods suggested by the author for furthering fuel economy through modifications in the carbureter is the use of water injection. This, he says, will permit a higher compression ratio, hence an increase in efficiency practically expressed in the saving of fuel per horsepower-hour. Another recommendation is to improve the flexibility of the carbureter in sudden accelerations or decelerations, and specific expedients for this purpose are listed. Emphasis is laid on various means for obtaining homogeneity, uniform distribution and vaporization of the fuel-air mixture.

In introducing his main theme, the author sets forth the difference between the actual and the ideal fuel-consumption of an engine. He then analyzes other features of engine design and performance besides carburetion that are responsible for the difference. Chief among these are mechanical efficiency, the relation between the advance in exhaust-valve opening and the retardation in inlet-valve closing, and the variations in pressure at the end of the inlet stroke.

Relation entre L'Admission et L'Échappement dans un Moteur à Quatre Temps. By L. Cazalis. Published in *La Vie Automobile*, Sept. 25, 1927, p. 369. [E-1]

In their concentration on the more efficient filling of cylinders with the fresh charge of fuel and air, engineers have lost sight of the equally important question of evacuating the waste products, according to the author of this paper.

In a series of articles on the interdependence of inlet and exhaust functions in a four-stroke cycle engine, of which the present treatise is the first, he will attempt to establish the strict relationship that exists between the two. In the present article, he follows through a complete cycle, dealing specifically with the temperatures and pressures at the end of each phase. He then determines the volume of gas to be evacuated, dealing with the exhaust process under two different sets of conditions. Under the first, purely theoretical, the exhaust operation is supposed to occur entirely at atmospheric pressure; in the second, the pressure is considered to be variable, and the exposition, in the interest of simplification, centers about eight definite points in the exhaust stroke.

Luftfilter für Verbrennungs-Kraftmaschinen. By K. R. H. Praetorius. Published in *Der Motorwagen*, Sept. 10, 1927, p. 551. [E-1]

With the increased use of automobiles in Germany for utilitarian purposes, the importance of engine durability is being emphasized more strenuously than formerly. As wear preventives, air-filters are receiving considerable attention, and several German devices, described in the series of which this article is a part, are now available commercially.

The Hirth filter is built on the centrifugal principle; the Orth device makes use of a coarse sieve to sift out the larger dust particles, and adjacent to the sieve is a group of spiral-formed canals in which centrifugal force casts out the finer dust. Much space is devoted to the product of the Deutschen

(*Coneinued on p.* 34)

What is the *perfect* BEARING SEAL

As Used in—
CATERPILLAR TRACTORS
TWIN CITY MOTORS
WISCONSIN MOTORS
CLEVELAND TRACTORS
YELLOW COACHES
CLEVELAND MOTORCYCLES
—and others

A perfect oil seal at crankshaft bearings must *combine* certain advantages. Advanced Engineering practice establishes NATIONAL SHIMS as the seal which meets these 3 major specifications:—

(1) Positively and permanently oil tight..... NATIONAL SHIM leaves do not compress under strain, brass on brass, no soft metal between. Each NATIONAL tip a permanent, integral part of the shim itself (see illustration). (2) Quick, easy, accurate service adjustments. NATIONAL SHIM leaves already separated, no time wasted pulling them apart. DOUBLE action—take off or put back leaves at will—no waste. (3) Full 360° of bearing surface with shims. NATIONALS leave no gap at bearing ends.

Submit blueprints for prices. Designs and suggestions by our engineers on request.

NATIONAL MOTOR BEARING CO., *Mfrs.*
DETROIT - - - - - - 222 West Larned Street
CHICAGO - - - - - - - - 6741 Sheridan Road
SAN FRANCISCO - 460-470 Natoma Street

NATIONAL tips can't break off or come loose Cast on main shim leaf, becoming permanent, integral part of shim.

"World's Standard"

1. Unit (laminated type) shims
2. Babbitt-faced shims
3. Steel Shims
4. Steel Bronze-faced shims
5. Copper liners
6. Brass liners
7. Steel liners

NATIONAL

Double-Action Non-Curling

SHIMS

(PATENTED)

Notes and Reviews

Continued

Luftfilter-Bauges.llschaft, of Berlin. This consists of several impact surfaces having corrugations extending, not parallel to one another or concentrically about the centerpoint, but in curved lines from the outer diameter to the center. Other filters described are the Pallas, the Güttner used in the Mercedes aviation engine, the Bartel, the Wölfel and the Delbag.

Neuere Anschauungen über Zünd- und Verbrennungsvorgänge in Dieselmotoren. By F. Sass. Published in *Zeitschrift des Vereines Deutscher Ingenieure*, Sept. 10, 1927, p. 1287. [E-1]

In an exhaustive treatise, the author reviews critically recent investigations and theories on ignition and combustion processes in Diesel engines.

Deferring to the opinions of P. Rieppel, early investigators propagated the theory that ignition in the combustion chamber of a Diesel engine is necessarily preceded by conversion of the fuel into an oil gas. Wollers and Ehmcke produced apparently convincing evidence against the possibility of gasification in the Diesel engine, and subsequent facts obtained by observation on running engines support their conclusions. After presenting the evidence that contradicted the first erroneous conclusion, the author reveals some work that tends to show that vaporization, too, is unnecessary for ignition.

The fuel droplets, then, must ignite directly in their liquid state after a previous preheating to a certain temperature which constitutes the ignition point. The results of measurements of the ignition points of different fuels in air and in oxygen at a pressure of one atmosphere and in air at the same pressure as obtains in a Diesel engine at the end of the compression period are given. Practical conclusions as to necessary operating conditions in Diesel engines are then drawn.

No answer has as yet been forthcoming, the author states, to the question as to how the injected fuel burns in a Diesel engine after ignition. Some considerations bearing on the possible process of combustion are advanced and are correlated with Diesel-engine design.

An Electrical Indicator for High-Speed Internal-Combustion Engines. By Jûichi Obata. Published in *Engineering*, Aug. 26, 1927, p. 253. [E-3]

The novel feature of the indicator described, which was developed at the Aeronautical Research Institute, Tokyo Imperial University, is stated in this article to be that it contains no mechanical part possessing appreciable friction or inertia, and is entirely free from the influence of the natural vibration of any part of the system. The disc of the indicator is 2 mm. (0.0788 in.) thick and 5 cm. (1.968 in.) in diameter, and an extremely sensitive electrical means records the minute motion of the disc caused by the pressure in the cylinder.

The detail construction of the indicator is described and examples of its use are cited.

HIGHWAYS

Rhythmic Corrugations in Highways. By H. V. Carpenter and H. J. Dana. Engineering Bulletin No. 19. Published by Engineering Experiment Station, State College of Washington, Pullman, Wash. 29 pp.; 15 illustrations. [F-4]

The formation of rhythmic corrugations, or "washboards," in gravel and crushed-rock highways never has been fully explained. Studies are here described, based, first, on experiments conducted with an oscillographic recorder in the tonneau of a car which gives a record of the variation in distance between the rear axle and the body when going over "washboards" and various other obstructions. These tests show that the rear axle frequently vibrates through vertical amplitudes many times greater than the depth of the corrugations.

(*Continued on p.* 36)

Notes and Reviews

Continued

Second, to avoid the complicating vibrations found in practice, a laboratory model of the rear end of an automobile was built which eliminates horizontal motion. The curves taken show the relationship in time between movements of the rear axle and the road corrugations and reveal that at certain speeds the greatest pressure of the tire on the road comes in the trough of the corrugation. The important effect of resonance also is shown.

Third, mathematical analyses based on the curves and the mechanics of the case are made in an attempt to explain many of the peculiar conditions found in these experiments.

MATERIAL

Density and Electrical Properties of the System, Rubber-Sulphur. Part I. Density of Rubber-Sulphur Compounds. By A. T. McPherson. **Part II. Electrical Properties of Rubber-Sulphur Compounds.** By H. L. Curtis, A. T. McPherson, and A. H. Scott. Bureau of Standards Scientific Paper No. 560. Published by Bureau of Standards, City of Washington. 35 pp.; 10 illustrations. [G-1]

Density and electrical properties of compounds of rubber and sulphur were measured for the range of composition from 0 to 32 per cent of sulphur, or from crude rubber to hard rubber. Important changes in the properties with the proportion of sulphur were noted. These changes show definite regularities and occur at compositions which may be represented by simple empirical formulas; they are, accordingly, taken as indicating the existence of definite compounds of rubber and sulphur.

Quenching: A Practical Study on Rapid Cooling. By Percy J. Haler. Published in *Mechanical Engineering*, November, 1927, p. 1187. [G-5]

The author of this article expresses the opinion that little progress in quenching methods has been made in many shops and attempts to throw some light upon various phases of this stage of heat-treating. After listing and defining four common ways of quenching, he tells of tests he made to determine the rate of plunging and of some attempts made by others to regulate the rate of quenching apart from spray quenching.

The influence of the direction of plunging on the distortion produced is the next topic discussed, and under this heading the effects of quenching on flat plates, solid and hollow cylinders and thin circular disks are described. A study is made of streamline motion in the cooling medium and results of tests made both by the author and by others are cited.

MISCELLANEOUS

Thermodynamics Applied to Engineering. By Arthur F. Macconochie. Published by Longmans, Green & Co., Ltd., New York City. 260 pp.; 65 illustrations. [H-1]

The purpose of this text is to present the principles of engineering thermodynamics in the simplest way and to illuminate these conceptions by reference to the best British and American practice in the major fields of their application. In the selection of examples for illustration, stress has been laid on recent developments likely to make a strong imaginative appeal on account of their unusual interest. A number of worked problems are included, together with tables of the thermodynamic properties of steam, ammonia, carbon dioxide and mercury vapor, all derived from the results of recent research.

The section devoted to the internal-combustion engine contains one chapter each on the following topics: general principles, the Diesel engine, the North British sliding-cylinder double-acting two-cycle Diesel engine, the gas turbine, calculated performance of gas turbines, the exhaust-gas turbine, and refrigeration.

(*Continued on p.* 38)

Notes and Reviews

Continued

The Influence of the Automobile User upon the Automobile Engineer. By E. G. E. Beaumont. Published in *The Automobile Engineer*, October, 1927, p. 393. [H-1]

Great Britain's automobile industry is in the throes of a great conflict between expedience and excellence, between cost and quality, with the former factor decidedly in the dominant position, according to this observer. Fully three-fourths of the vehicles sold in England today fall in the cheap-car class. This competition for cheapness is not native-born or natural; it is largely the outcome of the importation of foreign products on a large scale.

Cheapness of construction has largely neutralized the benefits of improvements in basic design and elaborations of details that have been evolved since the appearance of the primitive "horseless carriage." It is also responsible for a number of structural weaknesses listed. Low original cost gives rise to early failures, to reluctance on the part of the owner to pay the necessary repair bills, to premature wear and reduced second-hand values, the root of the used-car evil.

Exceptions to this general tendency are seen in the limited high-grade passenger-car production and in the manufacture of heavy commercial vehicles of both goods and passenger-carrying types. In the case of the motor-truck and the motorcoach especially, the influence of the user has been definitely to encourage the best practice as affecting reliability, durability and good performance. In aeronautical engineering, too, the quest for excellence is still unabated.

Some signs of the times point toward a return to a quality instead of a price standard. In America the influence of the user is being thrown in favor of the superior automobile and a rapidly growing dissatisfaction with the cheapest car is becoming evident.

The Functions of Research. By Charles F. Kettering. Published in *Industrial and Engineering Chemistry*, November, 1927, p. 1212. [H-1]

Scientific or so-called pure research has often been lauded for its virtues and accomplishments; in this article industrial research is thrust forward to its place in the sun. To quote the author,

> We of industry perhaps represent a very much lower order of thought than the pure science researcher, but we are able at least to translate it into the terms of the man on the street. We represent the 114,750,000 people of the United States who pay the bills of translating the wonderful discoveries of physics and chemistry into the terms of the average man.

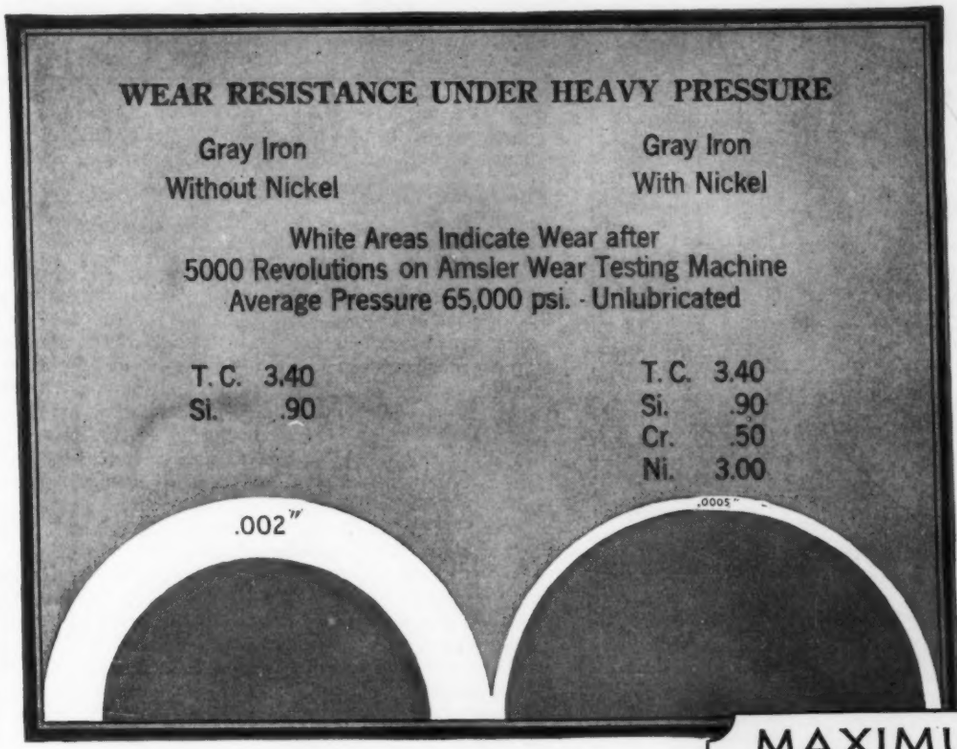
This translation of science into the terminology of the man on the street is one of the great functions of industrial research. Other functions are to sell its products, ideas; to keep everyone reasonably dissatisfied with what he has; to develop for the industrial world systematic change-making that will keep step with the everyday progress of the scientific world; and to fix what is wrong with what you have.

This bare outline is filled in with the author's epigrams and sharply-pointed remarks, the products of his long thoughtful observation and keen analysis in the field of research.

A Burette for the Accurate Measurement of Gas Volumes Without Gas Connection to a Compensator. By E. R. Weaver and Martin Shepherd. Bureau of Standards Scientific Paper No. 559. Published by Bureau of Standards, City of Washington, 7 pp.; 2 illustrations. [H-1]

This paper describes a burette for measuring gas volumes that embodies a novel compensator designed to eliminate errors of diffusion into the manometer. The burette is of the type having several bulbs of equal volume and a side-arm for measuring fractional parts of these volumes. Mercury levels in the side-arm are read by means of a vernier scale that gives high accuracy within a comparatively short length.

(*Continued on p.* 40)



WEAR RESISTANCE TESTED SCIENTIFICALLY

Diagram above illustrates principle employed by Amsler Wear Testing Machine.

Nickel additions increase the wear-resistance of iron castings

Present-day demand for improved quality of castings is directing progressive foundrymen to a study of new ways and means of producing better-wearing gray iron castings. These practical men are devoting special attention to such parts as cylinder blocks, liners, sleeves, pistons, gears, cams, etc.—parts where wear-resistance is essential.

1.	Finer grain	—
2.	Increased hardness	—
3.	Uniform hardness	—
4.	Increased strength	—
5.	Reduction of chill	—
6.	Increased hardness with decreased chill	—
7.	Better machinability with greater hardness	—
8.	Greater strength with better machinability	—
9.	Stabilized machinability	—
10.	Increased wear-resistance	✓

This advertisement is one of the series summarized above. Reprints of previous advertisements will be mailed you on request.

The results of the test on the Amsler Wear Testing Machine charted above are conclusive evidence of the increase in wear resistance secured under the conditions indicated, by the addition of Nickel. These results are being confirmed by the increased service life secured from Nickel iron castings in a wide range of commercial applications.

But increased wear-resistance is only one of the many advantages of adding Nickel to gray iron. In general, Nickel additions actually *extend the limitations of Cast Iron.* If you require more information concerning Nickel Cast Iron, we suggest that you write to our engineers, who will be glad to show you how to secure "Maximum Machinable Hardness" in your castings.

INCO NICKEL TRADE MARK **Nickel** INCO NICKEL TRADE MARK

THE INTERNATIONAL NICKEL COMPANY (INC.), 67 WALL STREET, NEW YORK CITY

Notes and Reviews

Continued

The burette proper is approximately 38 cm. (14.961 in.) in length with a total capacity of 125 cc. (7.628 cu. in.) An accuracy of 0.01 cc. (0.0061 cu. in.) is obtained readily.

The Mathematics of Engineering. By Ralph E. Root. Published by the Williams & Wilkins Co., Baltimore. 540 pp.; 115 illustrations. **[H-3]**

This book is an outgrowth of 13 years of effort on the part of the author, professor of mathematics and mechanics at the post-graduate school, United States Naval Academy, to meet the requirements of student officers at that institution. The book is a gradual development, chapters first appearing to supplement and then to replace a standard textbook. Various groups of the student officers specialize in different branches of engineering and receive, as final preparation, one or more years of advanced technical instruction at a university or technical school that is preeminent in the specialty of the group concerned. A book meeting the requirements of these students will, it is thought, approximate the mathematical requirements of the modern engineer.

Some of the material included is elementary, such as that on the solution of equations, the process of integration and standard curves, equations and transformations. Brief condensed statements covering topics of this type are offered to give the reader the opportunity of making essential reviews in the minimum of time. At the other extreme, that of the more advanced topics, the work admittedly stops short of the complete treatment that a specialized mathematician might desire. More emphasis has been laid on the inclusion of topics of a sufficiently wide range and on giving to each the amount and kind of discussion best suited to the needs of the engineer. To maintain the engineer's point of view, also, certain illustrative material has been drawn from technical subjects, and many of the exercises are chosen to suggest the practical bearing of the mathematical topic in hand.

Although intended primarily for the student who is to benefit by classroom discussion, this book can be used by the independent reader who is familiar with conventional courses in mathematics.

Year Book on Commercial Arbitration in the United States. Published by Oxford University Press, New York City. 1170 pp. **[H-3]**

This compendium of information on the facilities available in this Country for the arbitration of commercial disputes was prepared by the American Arbitration Association and is the first volume of its kind to be issued. It tells American business men and members of trade associations when and how they can secure arbitration in their particular trades, what such arbitration will cost, what rules will govern the decisions, and the steps that can be taken to put the awards into effect. The activities in this field of associations in 30 different lines of manufacture, of the National, international, State and local chambers of commerce, of Government departments, legal and quasi-commercial organizations are set forth. In appendices, State, Federal and foreign laws on arbitration are analyzed, and directions are given for the establishment of arbitral facilities in trade associations.

The automotive industry is said to have had a limited experience with arbitration, largely confined to dealers in accessories; in support of this view information is given on the following organizations: Automotive Equipment Association, Automotive Manufacturers' Association, National Standard Parts Association, the Iowa Automotive Merchants' Association, Inc., the Automobile Trade Association of Philadelphia, and the Pittsburgh Automobile Dealers' Association. The first three named and the Automobile Merchants' Association of New York are affiliated with the American Arbitration Association, which is a voluntary educational organization having a membership of 881 individuals, firms and corporations. It has affiliated with it 250 trade and professional organizations.

(*Continued on p.* 42)

Notes and Reviews

Continued

American Society for Testing Materials Index to Proceedings, Vol. 21 to 25 (1921 to 1925). Published by American Society for Testing Materials, Philadelphia. 224 pp. [H-3]

An especially helpful feature of his index to nine volumes of the Proceedings of the American Society for Testing Materials is the list of key-words given separately at the beginning of the volume. The key-words aid the seeker for information in finding where any particular topic is likely to be found in the subject index, which constitutes the second section. The key-words are not restricted to the words in the titles of reports and papers, but they direct attention also to the pertinent matter in the body of reports, papers and discussions. They are also plentifully cross-referenced. The third section is an author index, and in the fourth section the contents of each individual volume are listed.

All material, exclusive only of routine business, is covered by the index. Committee reports are indexed in two ways: first, under the subject designated in its title and, second, under appropriate key-words.

Wages and Hours of Labor in the Motor-Vehicle Industry, 1925. Bulletin of Bureau of Labor Statistics No. 438. Published by Government Printing Office, City of Washington. 113 pp. [H-5]

In this pamphlet are assembled illuminating statistics, comprehensive and detailed, on the hours of labor and the earnings of workmen in the motor-vehicle industry in 1925. The data are drawn from the payrolls and other records of 99 establishments, including manufacturers of passenger-cars, trucks, motorcoaches, bodies and parts. They cover a total of 144,362 wage earners, or 35.6 per cent of the whole number reported in the motor-vehicle industry by the 1923 Census of Manufacturers. The total includes 3432 females.

The tables itemize the earnings according to hourly and weekly averages for a large number of employe classifications. The 20 pages in which these classifications are listed alphabetically, defined and then regrouped in production departments, constitute an interesting survey of automobile factory organization. In addition to the statistics, comments are made on such topics as bonus systems and incentives, overtime payments and the growth of the industry.

MOTORCOACH

Buses and Bus Materials at Electric Railway Show. Published in *Motor Vehicle Monthly*, October, 1927, p. 25 [J-1]

An entirely new contribution to the motorcoach field that made its appearance at the recent exhibition of the American Electric Railway Association is the product of the Twin Coach Corporation, of Kent, Ohio. An exhibit credited with being of special interest is that of the Lang Body Co., of Cleveland. This is an all-steel body said to weigh not more, and perhaps less, than a wood or composite structure. To provide accessibility for repair purposes, the lower, side and rear panels are removable from the body without disturbance of the seats, heaters or any interior finish except a metal molding. Other products mentioned in this summary of the highlights of the exhibition are Baker and Fremont bodies; International Harvester, Mack, Six-Wheel, Studebaker, White, and Yellow motorcoaches, and a number of accessories.

Electric Railways Now Operating More than 8350 Buses. Published in *Aera*, October, 1927, p. 332. [J-4]

A normal stage has now been reached in the development of the use of motor-vehicles by electric railways and the number of companies operating motorcoaches will vary from this stage only by degrees in comparison with the rapid increases since 1921. However, the number of vehicles operated and the miles of route covered probably will continue to mount at a high rate.

(*Continued on p.* 44)

Notes and Reviews

Continued

These conclusions are based on the yearly census of electric-railway operation of motorcoaches presented in this article. The tabulated information, which covers about 30 pp., includes a complete list of electric railways operating motorcoaches, the extent of their operations, the dates of inauguration of the services, types of service, and the number, makes and seating capacities of the motorcoaches operated by each company. Information is also given on the extent to which standees are permitted.

The Regulation of Interstate Motor Transportation. By C. M. Kneier. Published in *Aera*, October, 1927, p. 291. [J-4]

This is a legal discussion of the regulation of interstate motor transportation, annotated with the decisions on which the conclusions are based. State and Federal decisions are stated to have defined with a fair degree of certainty the principles governing such regulation.

In the first place, a State cannot exclude from the use of its highways a carrier engaged in interstate commerce by refusing to grant it a certificate of convenience and necessity. Where the interstate carrier also does an intrastate business, the operations within the State are subject to regulation by the State, even though thereby interstate commerce may be affected indirectly. For carriers engaged exclusively in interstate commerce, regulations may be adopted by the State to promote safety on the highways and conservation in their use. This ruling will permit the imposing of license or privilege fee for the use of the highways, but will not permit the requirement of liability insurance or an indemnity bond for the payment of claims resulting from injury to persons or property.

These principles apply only to common carriers; they cannot be made applicable to a private carrier engaged in interstate commerce and in the hauling of goods under contract for factories.

PASSENGER-CAR

Modern Chassis Features Analyzed. Published in *The Motor*, Oct. 19, 1927, p. 559. [L-1]

Following a custom of long standing, *The Motor* publishes as part of its Olympia Automobile Show number an analysis of the status of and trends in automotive design. The conclusions drawn are based on the specifications of 305 individual chassis, not makes, available on the British market. As regards countries of origin, these cars are apportioned in the following percentages: Great Britain, 45; France, 24; United States and Canada, 16; Italy, 6; Belgium, 2½; Austria, 1½; Germany, 3½; and all others, 1½. Graphs and tables show the relative popularity of the various treatments applied to 14 engine or chassis features.

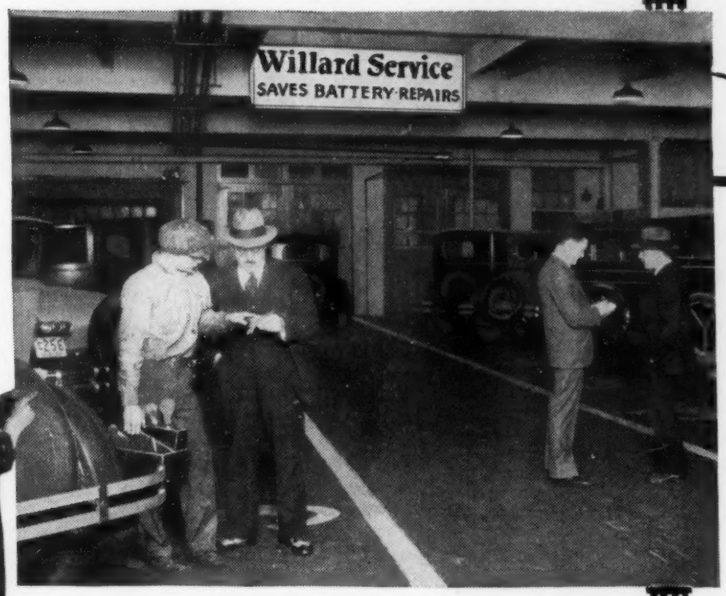
La XXI^{e} Exposition Internationale de L'Automobile. By C. Martinot-Lagarde. Published in *La Technique Moderne*, Oct. 15, 1927, p. 653. [L-1]

One of a large number of articles appearing in current French periodicals dealing with the Twenty-first International Automobile Show and the tendencies it reveals, this summary of design features lays particular emphasis, in the section on engines, upon the steadily rising engine-speed.

The six-cylinder engine is continuing its advance into popularity. Formerly employed only where considerable power was desired, it is now being used in smaller sizes and for the production of lower outputs. The eight-cylinder V-engine is not represented in France, the straight-eight has been adopted for certain Panhard-Levassor and Bugatti models, and the four-cylinder engine remains the conventional powerplant for small passenger-cars and business vehicles.

Lower centers of gravity and the increasing use of servo-brakes are two of the many chassis features mentioned. Special care is being taken to dampen the vibrations of the

(*Concluded on p.* 46)



STORAGE BATTERY
Willard
SERVICE STATION

WE tell car owners, in our current advertising, that we wish every one of them could spend a day in a Willard Service Station.

That invitation stands for car builders, and car dealers, too.

A Willard Battery Station is the best place in the world to see how real service saves money for your owners. The kind we give, plus the liberal margin of extra value in the Willard Battery, is the reason why Willards last longer and serve better.

We're Talking to Owners of Your Cars

Again, in Saturday Evening Post and the leading farm publications, we are featuring the importance of Willard Service for the cars you build, sell or service.

The Willard Battery Men

We service all makes and sell Willards for all cars, for farm-light, and for radio, too.

Notes and Reviews

Concluded

front end in some way, and the problem of suspension at high speeds is being solved in new and interesting ways.

This article deals, in general, with tendencies and not with individual models. One chassis, that of the 15-hp. Sensaud de Lavaud, tempts the author, by its novel construction, to a full and detailed description.

New Cars Show Gradual Evolution of Design Taking Place. By P. M. Heldt. Published in *Automotive Industries*, Oct. 15, 1927, p. 565. [L-1]

The author of this paper presents, as evidence of the thoroughness with which he has surveyed the field of current automotive engineering, many detailed observations and indicates the trends that have become clearly defined, the fields in which a clear-cut division of opinion is evident, and some innovations of too recent date to justify the formulation of any judgment.

Chief among the claims to fame that the current year will have is the thorough overhauling of design in the low-priced-car field. Larger piston deplacements and higher compression-ratios are among the features that have definitely established themselves. On greater engine-speeds and on car lengths manufacturers are still at odds. Rear treads are increasing in width and progress has been made in the adoption of counterweights on crankshafts, and of oil, air and fuel-cleaners. These are among the host of observations made on the design and material of the engines, chassis and bodies of current models.

The Austin Works System. Published in *The Automobile Engineer*, October, 1927, p. 380. [L-5]

An interesting feature of the production and labor control-system herein described is the method of bonus payment to indirectly productive labor, the phrase applied to what is more commonly known as non-productive labor. A certain sum, based on a percentage of the total output of the factory, is set aside each week for this class of employe. This is divided by apportioning to each individual concerned a certain number of units of bonus corresponding to the extent of responsibility and the general efficiency of each. The value of the unit bonus thus varies inversely as the number of persons engaged, which is an incentive to maximum effort. On the other hand, should the indirectly productive labor be unduly reduced, productive labor would begin to suffer owing to inadequate service, so that the total bonus, and with it the value of each unit would decrease.

The organization of the Austin factory is stated to be based on the realization that simplicity is the first essential of a successful system and that initiative must be encouraged instead of being cramped by red tape.

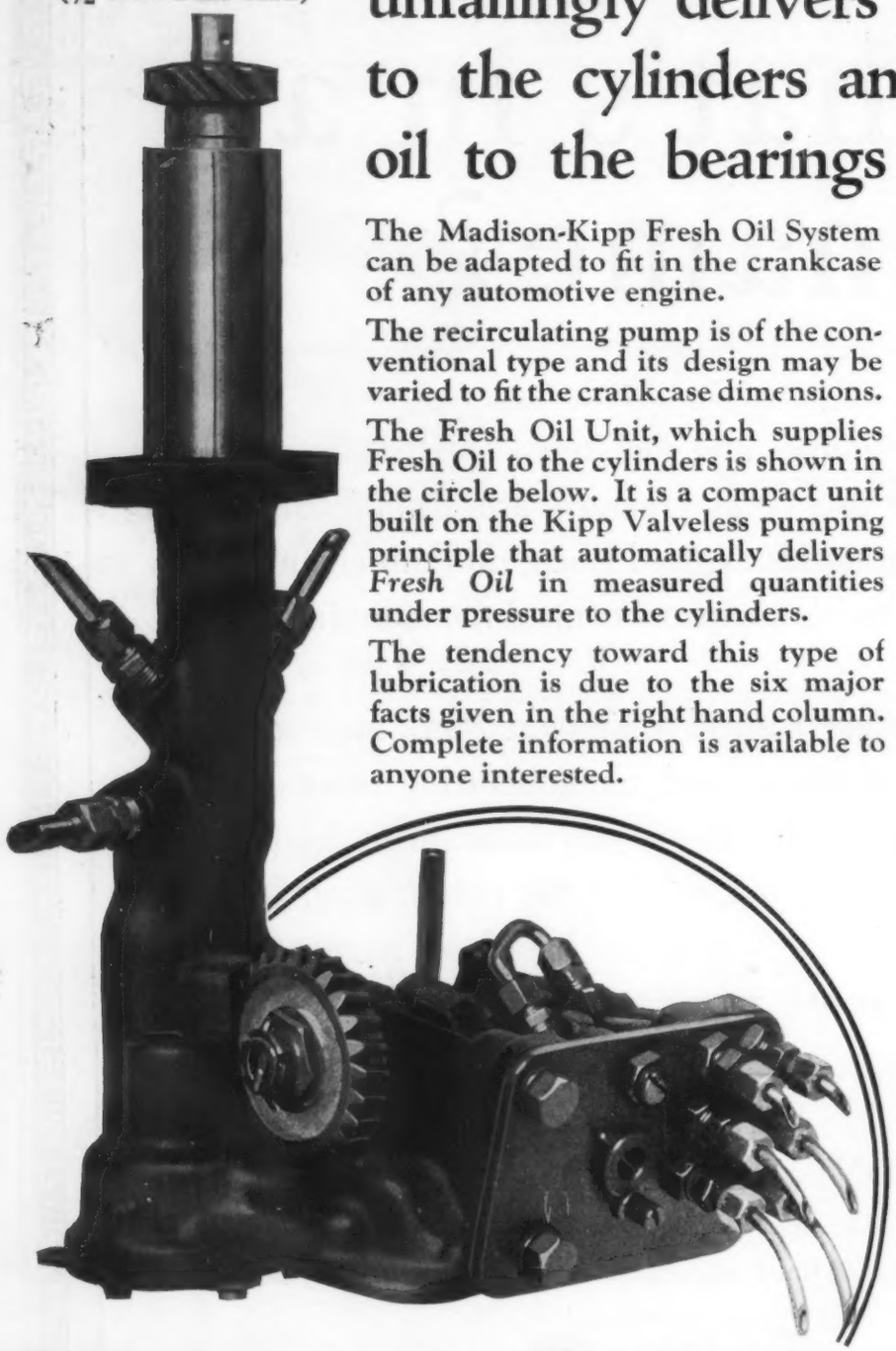
Wandlungen im Automobilbau und ihr Einfluss auf die Verwendung legierter Stähle. By H. Franz. Published in *Der Motorwagen*, Oct. 10, 1927, p. 607. [L-5]

Until very recently the line of technical development in the automobile industry in Germany pointed clearly toward one goal, the highest performance coupled with the smallest possible cylinder capacity and the increase of ultimate car-speed. The influence of foreign importations turned the minds of the purchasers in other directions. Acceleration, flexibility, and fair car-speeds at engine-speeds that are not excessive are now the desired characteristics. The question of fuel economy is also receding into the background.

With the automobile changed in character from a sport accessory to a necessary utility, German industry is confronted with the task of manufacturing vehicles that will meet American competitive products both in operating characteristics and in price, and exceed them in wearing qualities. Materials, especially steel, play a large part in the accomplishment of this end. This article was written to answer the question: What can be done, in view of the change in automotive construction, to lower the materials bill and simplify the treatment of the metals used? Engine and power-transmission parts especially are considered.

This is the Madison-Kipp Lubricator that fits readily into any crankcase and unfailingly delivers *FRESH OIL* to the cylinders and recirculated oil to the bearings only.

(½ ACTUAL SIZE)



The Madison-Kipp Fresh Oil System can be adapted to fit in the crankcase of any automotive engine.

The recirculating pump is of the conventional type and its design may be varied to fit the crankcase dimensions.

The Fresh Oil Unit, which supplies Fresh Oil to the cylinders is shown in the circle below. It is a compact unit built on the Kipp Valveless pumping principle that automatically delivers *Fresh Oil* in measured quantities under pressure to the cylinders.

The tendency toward this type of lubrication is due to the six major facts given in the right hand column. Complete information is available to anyone interested.

The Facts About Fresh Oil

Fact 1—Fresh Oil, delivered directly to each piston by a Madison-Kipp Lubricator immediately upon starting the motor, prevents the cold-weather wear that occurs in motors which depend upon oil thrown from the crank pins to provide cylinder lubrication.

Fact 2—Fresh oil carries no abrasives, and thus increases materially the efficient life of cylinders and pistons.

Fact 3—By providing fresh oil lubrication for the cylinders, even the bearings receive better lubrication. The crank case oil need not come into contact with the hot pistons and cylinder barrels. The resulting lower oil temperature lengthens the effective life of the crank case oil.

Fact 4—Oil pumping is prevented by providing fresh oil in *automatically controlled* quantities to the cylinders. The amount of fresh oil automatically delivered is ample for proper lubrication, but is so limited that it cannot cause oil pumping into the combustion chambers.

Fact 5—Because the use of fresh oil for the cylinders permits proper piston fits and correct piston design, it very often enables a given engine to develop greater power.

Fact 6—The use of fresh oil for the cylinders reduces the total oil consumption of the motor. The fresh oil lubricator uses a very moderate amount of lubricant and the crank case requires less frequent draining.

FRESH OIL

Madison-Kipp CORPORATION *Lubricators*

Lubrication Specialists Since 1898 *Madison, Wisconsin U·S·A·*

LYNITE

Reg U S Pat Off

Strong aluminum alloys can be made into any design or type of piston to meet individual specifications

Lynite, strong aluminum alloys, made of Alcoa Aluminum, were created many years ago by Aluminum Company of America. ¶ Most exhaustive tests and experiments resulted in the development of Lynite Pistons and Connecting Rods. ¶ Research and engineering by Aluminum Company of America covers all fields from raw material to finished product. ¶ Manufacturers and engineers who wish to determine the relation of Lynite to performance, in motors of their own design, are invited to make use of this engineering talent and experience.

LYNITE PERFORMANCE

Greater speed — more pulling power.
Several seconds quicker acceleration.
Less wear on cylinders and bearings.
Vibration reduced to a minimum.
Less weight — greater fuel economy.
Cooler motor — with less carbon.

ALUMINUM COMPANY OF AMERICA
PITTSBURGH, PA.
ALUMINUM IN EVERY COMMERCIAL FORM

THE WORLD'S LARGEST PRODUCERS OF DIE-CASTINGS

Doehler Die-Cast zinc alloy Carburetor

THERE is but one standard by which the Doehler organization gauges production . . . the best. This uncompromising attitude has attracted . . . and held . . . the patronage of America's greatest industrial enterprises. Since 1906 the leadership of Doehler Die Castings has rested on engineering and metallurgical expertness . . . plus the mechanical resources to insure vast production. And now, in 1927, three complete Die Casting plants and a separate division for assembly, makes the certainty of deliveries a fact beyond even unusual contingencies. ¶Consider us at your service in solving YOUR Die Casting problems.

Also designers & manufacturers of DOEHLER *Vending Machines for selling, sampling and advertising purposes.*

DOEHLER DIE-CASTINGS

DOEHLER DIE-CASTING CO. Brooklyn, N.Y. ~ *Plants at* Toledo, O. Batavia, N.Y. Pottstown, Pa.

When rutted roads bring rattles–

Hinges—tight and quiet when a car is new—may gradually be sprung or loosened by the strains of average driving. Then come the rattles!

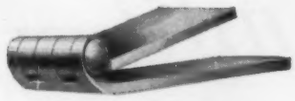
When hinges permit doors to rattle, they take on great importance in the driver's mind. He remembers the trouble when he selects his new car.

Correct analysis of steel and close adherence to dimensions are necessary to make a hinge that will stand up under the severe strains put upon it—and stay quiet.

Our 80 years' experience in making hinges of all kinds particularly fits us to take care of your hinge requirements. Some of the largest automobile manufacturers in the country are now using Stanley Hinges. If we can satisfy their exacting requirements, then we can satisfy yours.

We invite inquiries for all kinds of steel stamping work. We are specialists in deep drawn parts.

THE STANLEY WORKS, NEW BRITAIN, CONN.
SPECIAL PRODUCTION DEPT.
Detroit New York Chicago San Francisco Los Angeles Seattle



Open-joint hinge

Five joints. The result of 80 years' experience. Made of special cold-rolled steel. Long life. Can be made in any thickness of material and with any required offset.

Solid head—concealed joint

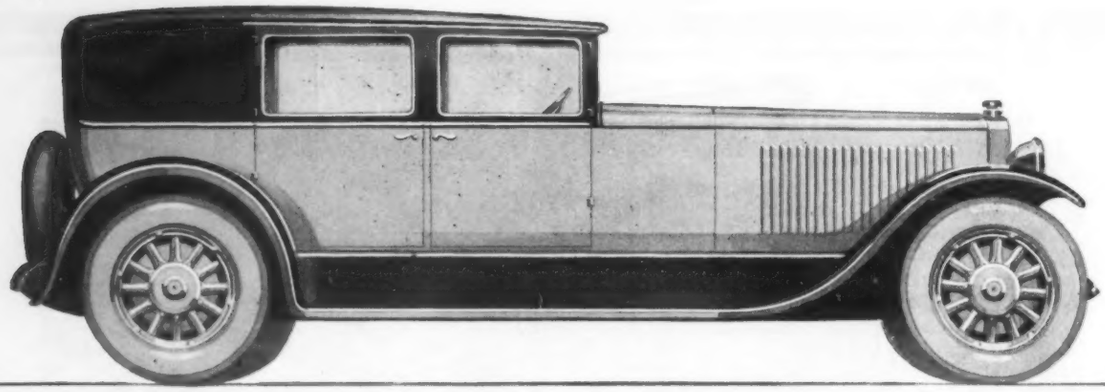
Head made of one piece—seamless. Will open to an angle of 90° or more. Made of special steel. Severe tests under actual operating conditions show that this hinge will last for the life of any car.

Concealed, demountable hinge

Especially designed for open cars. Demountable feature permits easy removal of door. No rattle. Cannot stick. Positive stop. 90°, or greater, opening angle.

Your silent salesman

STANLEY
AUTO HINGES
MADE OF STANLEY STEEL



Beautiful and USELESS!

until — your foot upon the Auto-Lite gives it life

A masterpiece of electrical mechanism produces this astounding transformation. Yet so faithful has been AUTO-LITE performance that the wonder of it is today taken for granted.

For many years, the owners of millions of automobiles have been subjecting AUTO-LITE to daily service tests. The remarkable manner in which these tests have been met, has put AUTO-LITE in a class apart. So near an approach to perfection is literally without precedent in the whole field of electrical mechanics.

An AUTO-LITE System on the car you sell is an index of quality materials used throughout. THE ELECTRIC AUTO-LITE COMPANY ' ' OFFICE AND WORKS ' ' TOLEDO, OHIO

Also Makers of DéJon

The Sign of Auto-Lite Service— a national protection for car owners

Auto-Lite

Starting, Lighting & Ignition

CASE

MARK

Medal Steel That Machines Freely

JALCASE For Soundness

Above is illustrated a bevel gear made from Cold Drawn JALCASE STEEL, .15 to .25 carbon, by a leading parts manufacturer of Cincinnati. This piece is not case-carburized or heat treated and JALCASE was adopted solely on account of the soundness of the steel and its improved machinability.

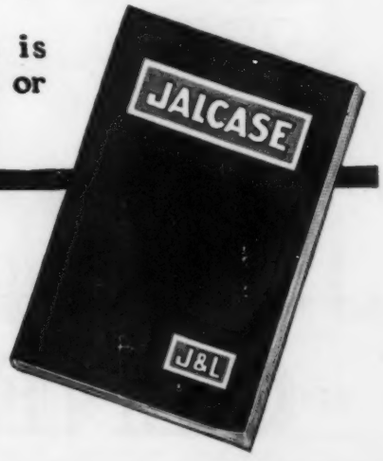
Case-Carburizes and Forges Excellently, and that Manufacturers of Machinery Parts Subject to Abrasive Wear and Repeated Shocks are Adopting in Steadily Increasing Numbers as They Find That JALCASE Saves Them Money.

How JALCASE saves money is shown in these brief phrases from users:

Speed of Automatics increased 34% — Automatic speeds increased 23% — Total increase in production of 94% — Secured 25% increase in production — 50% increase in drilling speed — Cut at surface speed of 180 ft. per minute, an increase of 29% over other steels — Cutting speed practically equivalent to Bessemer screw stock — Feed increased 45% — Estimated saving of $28 a ton — 15% increase in carburizing time — Shows a saving in carburizing costs — Considerably less distortion, hence reduced straightening costs — 108 pieces on the automatic machine without regrinding as against 50 pieces other steels — 5 to 10 points scleroscope hardness above other steels — Uniform hardness 62 to 65 (Rockwell) free from soft spots — Rate of carbon penetration greater by 15% to 25% than in other grades of case carburizing steel — Tool life extended nearly five times.

The highest award at the Philadelphia Sesqui-Centennial—The Grand Prize—was bestowed upon Jones & Laughlin Steel Corporation for their Cold Rolled and Cold Finished Steels, which they have been manufacturing for upward of 60 years.

JALCASE STEEL is Finished in Hot Rolled or Cold Finished Bars



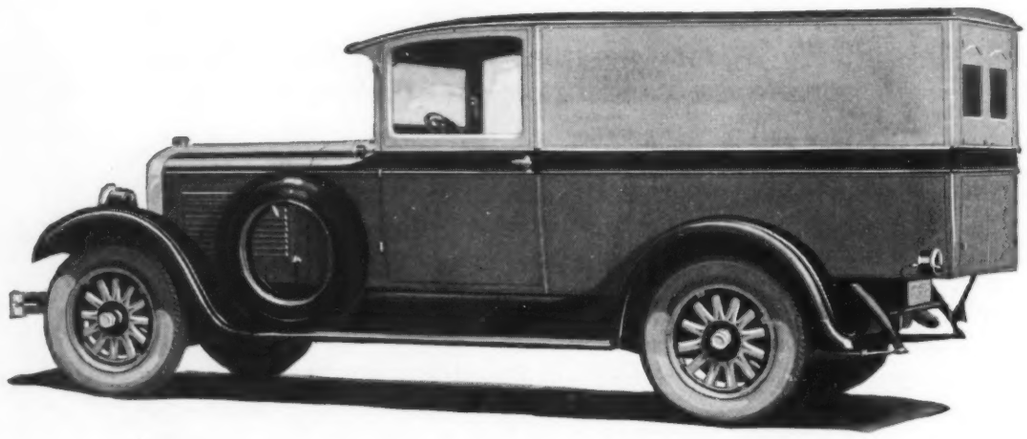
CORPORATION

Pittsburgh-Pa.

Send for this 50 page Hand Book

REO "SPEED WAGON JUNIOR"

Hayes Body



A Notable Addition to a Notable Line

Reo's record is sensational, not so much because it has established new records, but because those who direct the company so correctly anticipated and so successfully met the needs and desires of the 1927 motorist and dealer.

It is significant that Reo is meeting the demand for a half ton delivery wagon with this "Speed Wagon Junior"—a notable addition to a line jealous of its reputation.

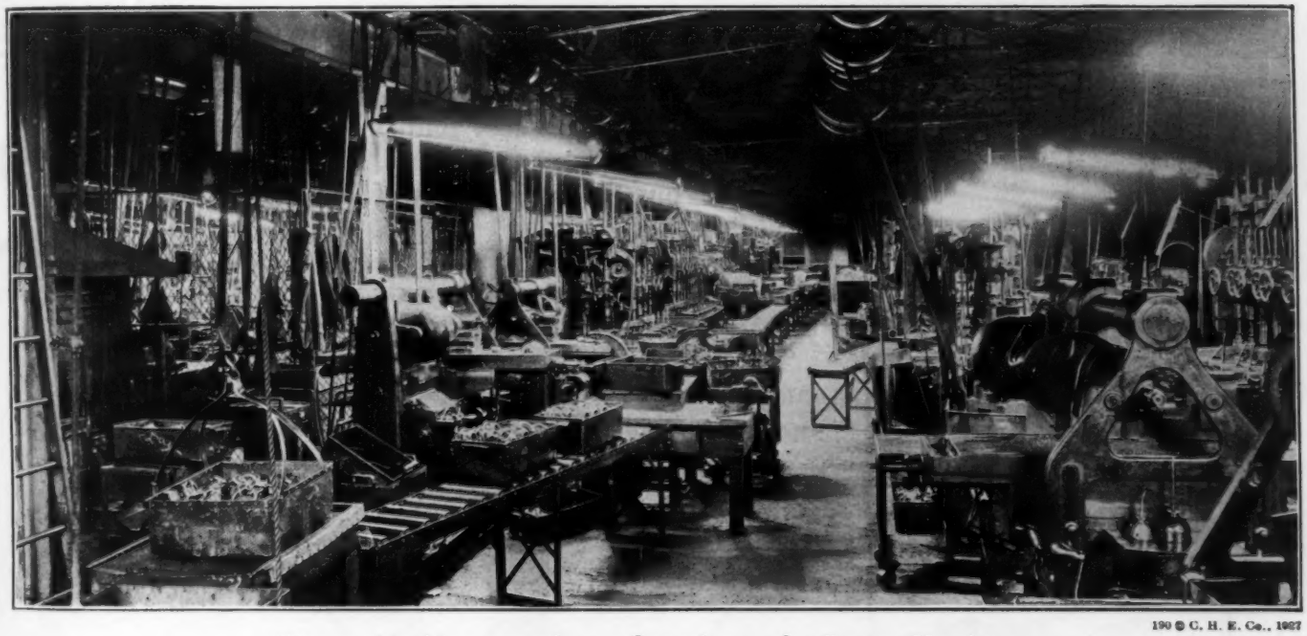
Hayes was privileged to originate and build this distinctive paneled body, and to endow it with beauty, quality and utility to match the performance and lasting service of a car whose slogan is: "No other American car lasts as long as Reo—not one."

HAYES BODY CORPORATION

The HAYES BODY Corporation

Grand Rapids, Michigan

Design and processes have been revolutionized and production increased many fold in this plant since it first used Cooper Hewitts. Its policy of constant betterment has improved nearly every detail of product and production—and the only improvement in lighting has been frequent increases in the number of Cooper Hewitts required.



No metal is shiny enough to reflect glare under Cooper Hewitts—no shadow heavy enough to affect instant, accurate seeing. Every man has as much light as the "other fellow," never changing in volume or value. Eyes are as capable at quitting time as when the work began. Try it in your plant; there's no obligation. Cooper Hewitt Electric Co., 119 River Street, Hoboken, N. J.

COOPER HEWITT

BETTER THAN DAYLIGHT

RED BALL Model "L" $10.00
(Illuminated)

RED BALL Model "S" $12.00
(Illuminated, Steering Column mtg.)

THE MOTOMETER COMPANY, INC.
LONG ISLAND CITY, N.Y.

OFFICE OF THE PRESIDENT

To the Automotive Trade:

It is a real pleasure to offer the new Red Ball Boyce MotoMeter. To me, it means more than just an item added to the MotoMeter line: it is the outgrowth of a personal experience, the practical expression of an idea that contributed to the success of the "Greenwich Folly" in winning the Gold Cup Classic.

The experience of years of boat racing suggested the device now offered in its perfected state as the Red Ball.

Driving a racing boat is not unlike driving a car: a constant knowledge of motor conditions is not only essential but vital. And - eyes must be kept on the course ahead; in the heat of competition, a quick, casual glance at the instrument board must suffice - at a flash it must mean one of two things: motor temperature that is either safe or dangerous.

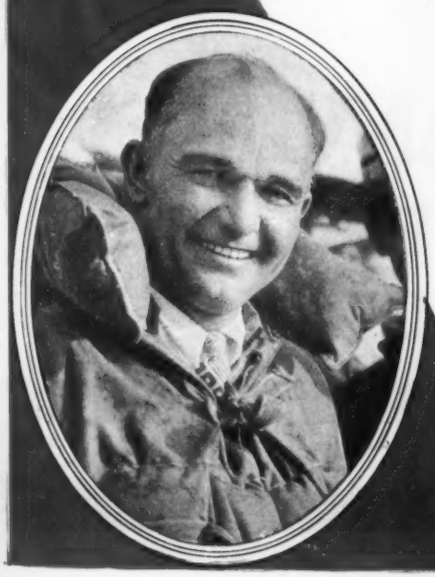
That, precisely, is what the Red Ball means to me at the wheel of "Greenwich Folly". A green ball of light on the dial is just a reminder of safe driving conditions - but, the instant the illuminated Red Ball flashes - and it can't fail to flag attention - I know it means - Stop! Investigate!

It is our belief that the Red Ball meets the present demand of a large part of your market for a warning signal on the dash. It is an advanced type of motor heat indicator that will unquestionably appeal to every motorist.

A friendly and profitable suggestion is to place orders NOW for immediate delivery. Quantity production makes it possible to offer the Red Ball at the same price as other Boyce MotoMeters of the dash type. Be ready to serve your market.

Geo. H. Townsend
President and General Manager.

G. H. TOWNSEND
At the finish of the Gold Cup race.



Of course the "Greenwich Folly" was equipped with MotoMeter self-adjusting Spark Plugs.

Around and around they go

SIX days and six nights the feverish grind pushes on · · · six days and six nights · · · a terrific pace · · · a wearying monotony · · · the stubborn courage to carry on · · · the six-day bicycle races in New York.

And the winner?

Not the boldest, not the most energetic, but the team (the two men) that can hold the ounce in reserve—two men whose bodies can respond when the final spurt is necessary—

—two men with *correctly tempered* bodies.

In the manufacture of wire springs the same law of logic holds.

It is not only the designs, the variety, nor even the materials from which they are made that can account totally for the leadership of Cleveland Wire Springs.

More than anything else it is *correct tempering*—the infusing of longer life and more resistance into every spring we manufacture—that has placed them in the high position they hold today.

Cleveland Wire Springs come to you with a reputation. A reputation for strength, endurance, reserve energy.

They cannot fail!

{Also manufacturers of Steel Shop Barrels, Tote Boxes, Steel Shelving, Steel Stools, Steel Waste Cans and Specialties.}

THE CLEVELAND WIRE SPRING COMPANY

Main Office and Factory, Cleveland, Ohio

Branches: CHICAGO, Machinery Hall · DETROIT, Garfield Bldg.

CLEVELAND

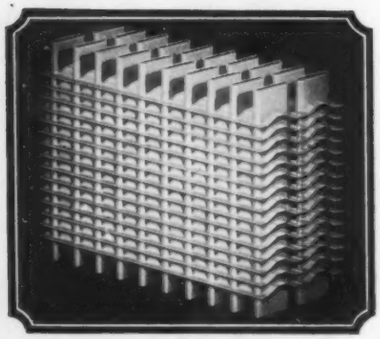
COILED AND FLAT SPRINGS

Wire Forms of All Kinds

"Specialists in Haulage"—Vulcan Standardizes on **Turbotube**

"SPECIALISTS in the Haulage field for over 50 years" — the Vulcan Iron Works, Wilkes-Barre, Pa., has standardized on **Turbotube** Radiators for its gasoline locomotives.

Above are shown two **Turbotube** equipped 8-ton Vulcan gasoline locomotives, in service at the Hutton Company plant, Kingston, New York, brick manufacturers.



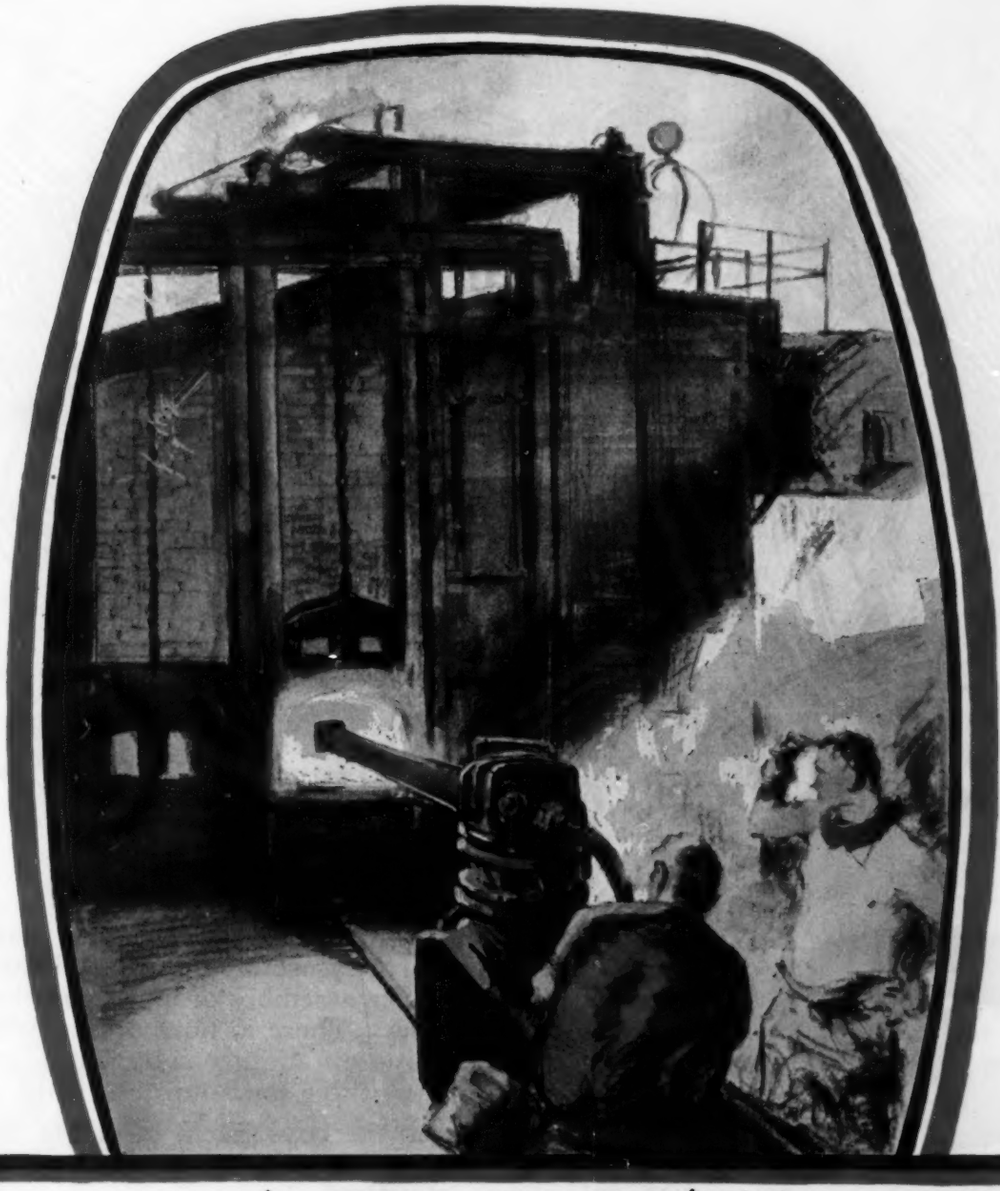
Patented **Turbotube** Core — built only by Modine — adaptable to trucks, busses, tractors, gasoline locomotives, oil engines and construction equipment of all kinds.

Light weight with extreme strength, higher cooling capacity per pound of materials used, unlimited guarantee against damage by freezing, sectional construction so that in the event of injury to core any section may be blanked off, the engine continuing in service until repairs or replacements are made — these are features that made **Turbotube** the choice of a company with a reputation built up through a half century of manufacture.

Let our engineers show you how to apply the advantages of **Turbotube** *to your equipment.*

MODINE MANUFACTURING CO.
RACINE WISCONSIN

MODINE RADIATORS



A New Mill

fitted with every known facility for meeting exacting specifications

To steel-making experience extending over decades, the Illinois Steel Company now adds a mill embodying the most advanced features yet devised for close-gauge rolling of alloy steel. · · Every item of equipment from furnace to pickling vat is of latest design. Every responsible position in the mill is filled by an alloy steel specialist. · · The result is alloy steel that not only meets your specifications but is of such physical quality that material savings are frequently effected in the purchaser's production costs. · · You owe it to yourself to place this dependable source of supply on your list.

Illinois Steel Company

Chicago

ILLINOIS *Alloy* STEEL

Who knows better than the mechanic who uses them?

THESE KANTLINK Lock Washers are just what we needed on the assembly floor—production has speeded up, cost per assembly dropped and the boys are all happy now. There is no more complaining about wasting time untangling a bunch of knotted lock washers when these hurry-up jobs come along.

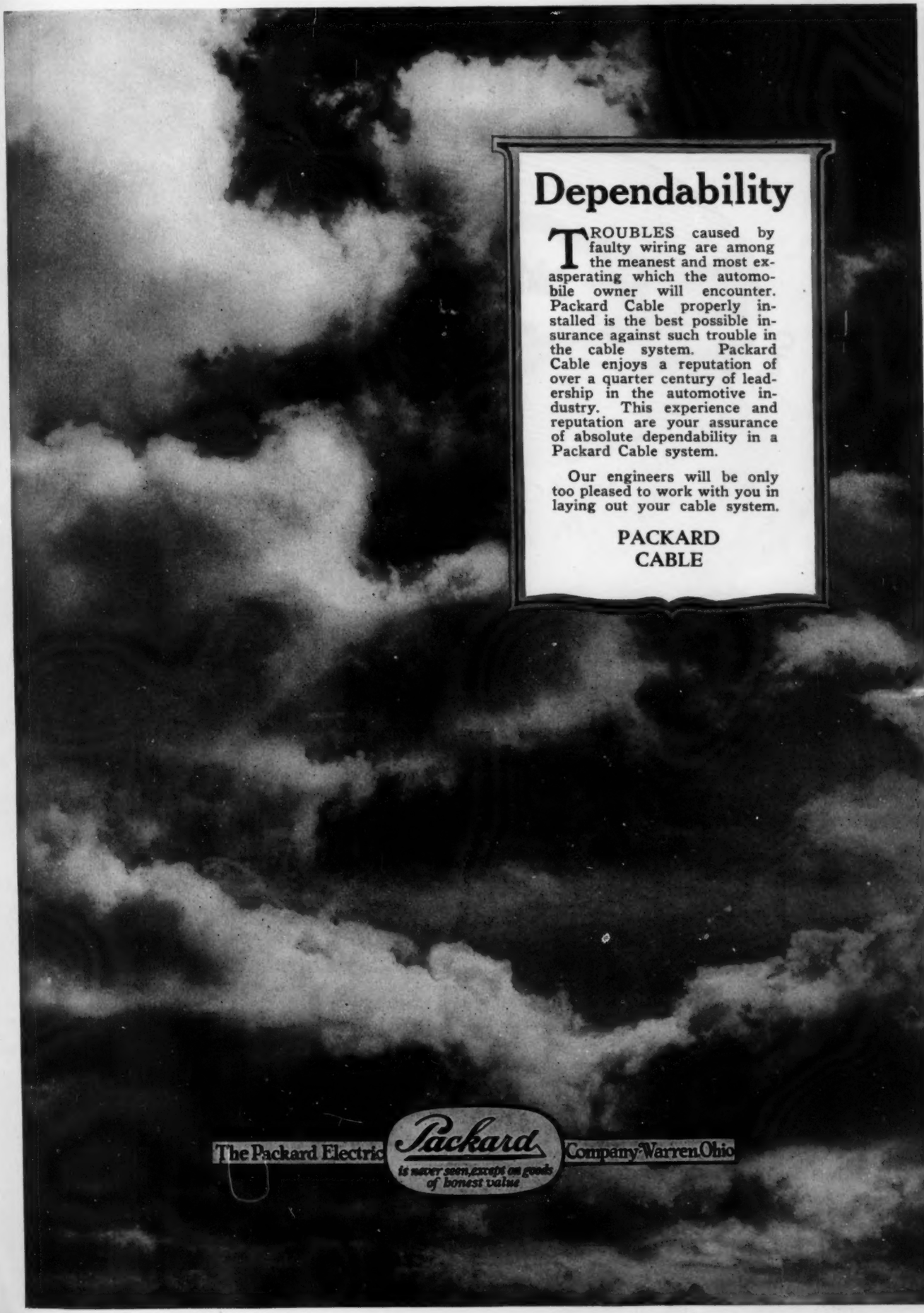
Before, whenever the boys got a string of tangled lock washers, they threw them away rather than untangle them. KANTLINK Lock Washers have eliminated this waste of time and material because they do not interlink.

We hear, too, from the test department, that KANTLINK Lock Washers give stronger assemblies because they have greater holding power and do not rust in service.

The National Lock Washer Co.
General Office: Newark, N. J.

Plants:
Newark, N. J. Riverside, N. J. Milwaukee, Wis.

KANTLINK
REGISTERED
PATS. PENDING
LOCK WASHERS


Dependability
TROUBLES caused by faulty wiring are among the meanest and most exasperating which the automobile owner will encounter. Packard Cable properly installed is the best possible insurance against such trouble in the cable system. Packard Cable enjoys a reputation of over a quarter century of leadership in the automotive industry. This experience and reputation are your assurance of absolute dependability in a Packard Cable system.
Our engineers will be only too pleased to work with you in laying out your cable system.
PACKARD CABLE
The Packard Electric
Packard
is never seen except on goods of honest value
Company Warren Ohio

Carbureter RESPONSIBILITY

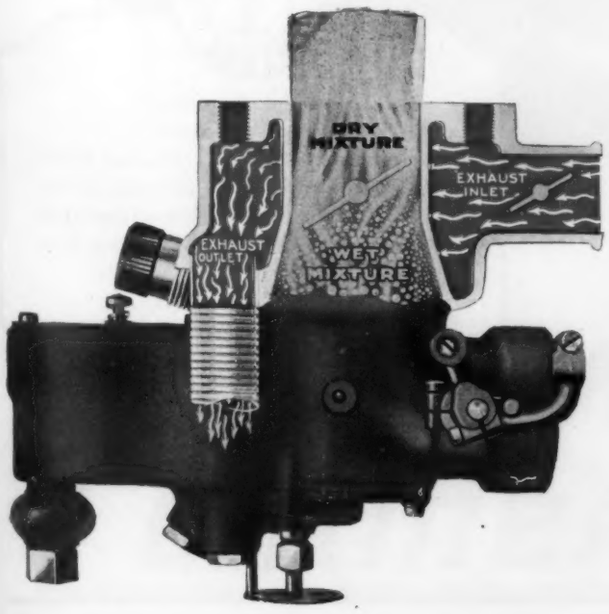
From the Standpoint of the Carbureter itself

FAR and wide, in the freezing north or under the hot sun of the equator. Mountains, mud or heavy traffic — Marvel Carbureters are functioning smoothly, powerfully and economically—THEY ARE MEETING THEIR RESPONSIBILITIES.

Marvel with its automatic heat control, its advanced principles of construction and manufacturing facilities, has sustained a reputation that is beyond question. A manufacturer who offers his product MARVEL EQUIPPED inspires confidence in selling and does much toward fulfilling his own responsibilities.

We believe that Marvel will go further toward selling a car and keeping it sold than any other carburetion system. We believe this is the kind of responsibility you have a right to expect from the carbureter itself.

MARVEL CARBURETERS and AUTOMATIC HEAT CONTROL — endorsed by their engineering staffs and installed by BUICK, NASH, HUDSON and OAKLAND.



Marvel Carbureter Company
FLINT, MICHIGAN

The Stewart laboratories keep materials and processes up to a high standard.

Die castings of consistent high quality by scientific control

AT The Stewart Die Casting Corporation the preparation of alloys and the conduct of die casting processes are governed by scientific control. A staff of competent chemists and metallurgists carry on analyses, compound alloys and keep accurate control of working temperatures. Metallurgists fit the proper alloy to the product. None but best quality virgin metals, analyzed to check their purity, are used in the composition of alloys. After being compounded the alloys are rechecked by analysis. They are then held for the chemists' approval before release to the die casting machines.

The Stewart engineering staff is often able, through experience, to adapt products to the Stewart process by modification of design and, in so doing, improve the product and greatly reduce the cost of production. These engineers design the dies which are made in a thoroughly modern, completely equipped and well manned tool room. Dies are made here by the most competent workmen obtainable, at a cost that is extremely moderate.

As assurance that no imperfect castings will be passed, a specially trained inspection department keeps pace with production. Imperfections in casting or finishing are quickly eliminated.

Full information on the application of the Stewart process to your product will follow your inquiry.

THE STEWART DIE CASTING CORPORATION

(Formerly Stewart Manufacturing Corporation)

4500 Fullerton Avenue, Chicago, Illinois

Direct Factory Representatives in

Detroit Milwaukee
Cleveland
New York City
Birmingham Pittsburgh
St. Louis

WATER-PROOF

The new Splitdorf Model "B" Magneto for buses, trucks and tractors

THE new Splitdorf Model "B" is a real achievement in ignition device manufacture—a water-proof magneto that will keep buses, trucks and tractors running in any weather. Bus transportation, truck hauling and tractor work must be continuous to be profitable. Reliable, trouble-proof ignition is a prime requirement of uninterrupted service.

Airplane magneto practice has been drawn upon largely in the mechanical and electrical design of this new instrument, which thus raises truck ignition to new heights of dependability.

This new Splitdorf Magneto makes use of the inductor principle and produces hot, fuzzy sparks at the lowest engine speeds. It makes starting easy, getaway fast and performance sure.

Both 20 and 30 degree timing range slots are provided—an advantage found only in this instrument.

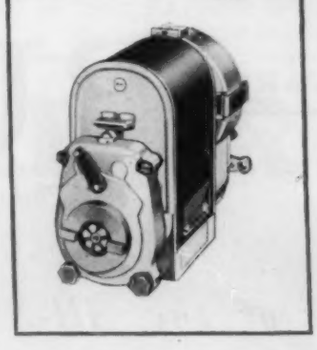
This new advanced type of ignition device—designed with Splitdorf experience and built with Splitdorf accuracy—is a guarantee of profit-making, continuous operation and money-saving reduction of repair bills. Splitdorf Electrical Company, 392 High Street, Newark, N. J., *Subsidiary of Splitdorf-Bethlehem Electrical Company.*

Model "B"—the new water-proof Splitdorf Magneto

Reg. U. S. Pat. Off.

TRADE SPLITDORF MARK

ESTABLISHED 1 8 5 6



Shove High Maintenance Cost Right Out of Your Books

IT can be done. It is being done. Air Springs are doing it every day for thousands of users.

It is the constant wrenching and vibration, the staggering blows of the road that increase maintenance costs, that swell repair bills and throw busses and trucks on the scrap heap long before their normal life should be expended.

Then there is the loosening of rivets and cross members and crystallization that bumpy roads snatch from your profits as daily toll charges.

Air Springs squelch these profit thieves. Air Springs roll high maintenance costs right out of your books.

Air Springs float the chassis on cushions of air—absorb the destructive blows that the roads aim at the body, motor and chassis—slice repair bills down to a minimum—eliminate unnecessary lay-ups and keep the entire fleet out on duty—*where it belongs.*

Air Springs pay for themselves in a very short time. In fact, they are saving users hundreds of thousands of dollars every year in decreased maintenance costs and in longer life of busses and trucks.

Write for more details and the name of our distributor nearest you

THE CLEVELAND PNEUMATIC TOOL CO. · *Cleveland, Ohio*

GRŪSS
Sleeve Type
AIR SPRING

WESTINGHOUSE
Piston Type
AIR SPRING

THE SHOCK ELIMINATORS FOR TRUCKS-BUSSES-PASSENGER CARS

Savings *by* Smith

Due to the wide experience and the extensive engineering staff of the A. O. Smith Corporation, it is frequently possible for this company to submit suggestions for improvement of frames. Our specialists in Frame Engineering work with the Frame Engineers and Executives of automobile companies, to secure great economy, utility, and freedom from trouble.

Economy and Improvement

Direct savings in cost combined with improvements in strength and utility have been effected by the Smith Engineering Service in 4 major ways.

1. The proper distribution of metal.
2. Fewer parts and rivets.
3. Lower manufacturing expense.
4. Easier assembly into the car.

Freedom from Trouble

Frequently the suggestions of the Smith Engineering Service have freed the customer from some operating difficulty that could be traced to frame design.

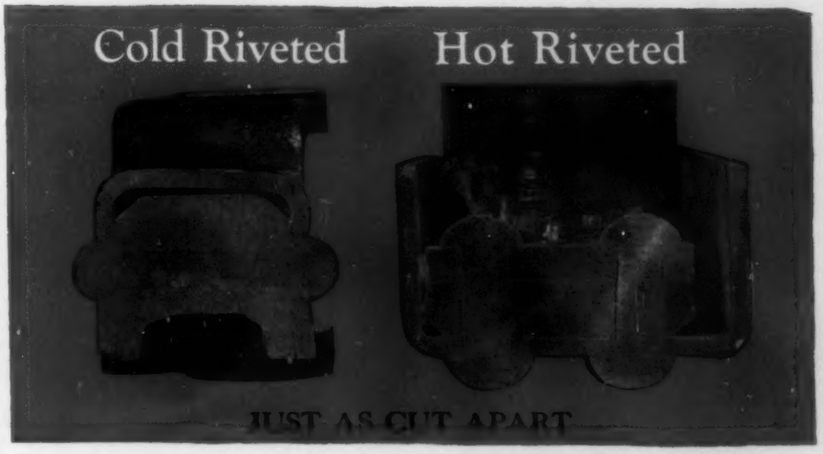
Engineering Service

This service is in charge of engineers who are specialists in the design and manufacture of automotive frames. It is available at any time—on new models long in advance of the time they will be in production. In this way the benefit of this service may be received at the time it is most valuable.

Manufacturing Facilities

The manufacturing facilities of the A. O. Smith Corporation are literally unrivalled in America or abroad. The South Plant, where frame assembly is largely automatic, is devoted to the fabrication of frames in quantities of 10,000 or over. Manufacture in the North Plant is semi-automatic and is confined to the production of frames ordered in smaller quantities.

The customer is thus assured that the frames he orders will be built by a method that will secure the utmost of economy for his volume.



HOT *or* COLD Rivets

The A. O. Smith Corporation makes and uses 316 tons of rivets per month—20,000,000 rivets.

We think we know something about riveting.

The above samples of hot and cold riveting were made up under identical conditions.

We leave it to you as to which is the better joint.

All Smithsteel Frames are regularly cold riveted.

A. O. SMITH CORPORATION, *Milwaukee, Wisconsin*
Auto Products Division

SMITHSTEEL FRAMES

DAYTON *Light* WHEEL

What is *Real* Wheel Economy?

It is human to "shop for bargains"—only to be checked up from time to time by sad experiences that bring a solemn resolution to "never again."

"Beware the higher cost of the lower price" is an adage that has guided many successful purchases.

Truck wheels are no different from shoes or tires or hundreds of other things in this respect.

There can always be found "price bargains" that usually turn out to be "service bugaboos." They bring no satisfaction to buyer or seller.

The Dayton Light Wheel for 1 and 2-ton trucks is built of electric furnace steel, with hollow-arched spokes, integral hub and felloe, in every way a *complete* wheel. It has all of the elements of superiority that have put Dayton Steel Truck Wheels on four out of every five heavy duty trucks.

Yet its first cost is so little more than that of the cheapest "price bargain" that truck manufacturers who will not dally with their reputation have accepted it unanimously.

Let us tell you about it, too.

THE DAYTON STEEL FOUNDRY COMPANY, Dayton, Ohio

STRENGTH
LIGHT WEIGHT
TIRE ECONOMY

Dayton

The Mark of a Good Wheel

DURABILITY
ACCESSIBILITY
APPEARANCE

MEMBERS' PROFESSIONAL CARDS

INDEX TO ADVERTISERS' PRODUCTS

Absorbers, Shock
American Chain Co.
Hassler Mfg. Co., Inc.
Houde Engineering Corporation
Watson Co., John Warren

Absorbers, Shock, Hydraulic
Monroe Auto Equipment Co.

Accessories, Punch Press
Danly Machine Specialties, Inc.

Adapters, Die
Threadwell Tool Co.

Adapters, Reamers
Threadwell Tool Co.

Adapters, Tap
Threadwell Tool Co.

Air Brake (See Brakes, Air)

Alloys, Alumino-Vanadium
Vanadium Corporation of America

Alloys, Aluminum
Aluminum Co. of America
Franklin Die-Casting Corporation

Alloys, Babbitt
Federal-Mogul Corporation
Franklin Die-Casting Corporation

Alloys, Brass
Copper & Brass Research Association
Mueller Brass Co.
Scovill Mfg. Co.

Alloys, Bronze
Copper & Brass Research Association
Dole Valve Co.
Mueller Brass Co.
Scovill Mfg. Co.

Alloys, Cupro-Vanadium
Vanadium Corporation of America

Alloys, Ferro-Chrome
Vanadium Corporation of America

Alloys, Ferro-Molybdenum
Vanadium Corporation of America

Alloys, Ferro-Silicon
Vanadium Corporation of America

Alloys, Ferro-Tungsten
Vanadium Corporation of America

Alloys, Ferro-Vanadium
Vanadium Corporation of America

Alloys, Silico-Manganese
Vanadium Corporation of America

Alloys, Solder
Copper & Brass Research Association

Alloys, Steel (See Steels)

Alloys, White Bearing
Franklin Die-Casting Corporation

Aluminum Castings, Die-Cast
Aluminum Co. of America
Franklin Die-Casting Corporation

Ammeters
General Electric Co.
Graybar Electric Co.
Nagel Electric Co., W. G.

Apparatus, Ignition
General Electric Co.
North East Electric Co.

Apparatus, Laboratory
Olsen Testing Machine Co., Tinius

Arc Welding (See Welding Equipment)

Axles, Front, Motor-Truck
Shuler Axle Co., Inc.

Axles, Front, Passenger-Car
Adams Axle Co.
Salisbury Axle Co.

Axles, Motorcoach
Clark Equipment Co.
Shuler Axle Co., Inc.

Axles, Rear, Motor-Truck
Clark Equipment Co.

Axles, Rear, Passenger-Car
Adams Axle Co.
Salisbury Axle Co.

Axles, Front, Tractor
Shuler Axle Co., Inc.

Axles, Trailer
Salisbury Axle Co.
Shuler Axle Co., Inc.

Balls, Steel
New Departure Mfg. Co.

Bands, Steel
Bethlehem Steel Co.
Donner Steel Co., Inc.
Illinois Steel Co.

Barrels, Shop, Steel
Cleveland Wire Spring Co.

Barrels, Tumbling and Burnishing
Globe Machine & Stamping Co.

Bars, Bronze
Federal-Mogul Corporation
Johnson Bronze Co.
Mueller Brass Co.
Scovill Mfg. Co.

Bars, Pry
Danly Machine Specialties, Inc.

Batteries, Farm Lighting
Electric Storage Battery Co.
Westinghouse Union Battery Co.
Willard Storage Battery Co.

Batteries, Radio
Electric Storage Battery Co.
Graybar Electric Co.
Westinghouse Union Battery Co.

Batteries, Storage
Electric Storage Battery Co.
Graybar Electric Co.
Westinghouse Union Battery Co.
Willard Storage Battery Co.

Battery-Boxes
Globe Machine & Stamping Co.

Bearings, Babbitt and Bronze
Bohn Aluminum & Brass Corporation
Federal-Mogul Corporation
Franklin Die-Casting Corporation
Johnson Bronze Co.
Mueller Brass Co.
Stewart Die-Casting Corporation

Bearings, Babbitt Metal
Federal-Mogul Corporation

Bearings, Ball, Angular Contact type
Ahlberg Bearing Co.
Bearings Co. of America
Fafnir Bearing Co.
Gurney Ball Bearings
McGill Metal Co.
Marlin-Rockwell Corporation
New Departure Mfg. Co.
S K F Industries, Inc.
Strom Bearings Co.

Bearings, Ball, Annular, Light, Medium and Heavy Series
Ahlberg Bearing Co.
Fafnir Bearing Co.
Federal Bearings Co., Inc.
Gurney Ball Bearings
Marlin-Rockwell Corporation
McGill Metal Co.
New Departure Mfg. Co.
Norma-Hoffmann Bearings Corporation
S K F Industries, Inc.
Standard Steel & Bearings, Inc.
Strom Bearings Co.

Bearings, Ball, Thrust
Aetna Ball Bearing Mfg. Co.
Ahlberg Bearing Co.
Bearings Co. of America
Fafnir Bearing Co.
McGill Metal Co.
Norma-Hoffmann Bearings Corporation
S K F Industries, Inc.
Standard Steel & Bearings, Inc.
Strom Bearings Co.

Bearings, Bronze
Federal-Mogul Corporation
Johnson Bronze Co.
Mueller Brass Co.

Bearings, Die-Cast
Federal-Mogul Corporation
Stewart Die-Casting Corporation

Bearings, Roller
Hyatt Roller Bearing Co.
Norma-Hoffmann Bearings Corporation
S K F Industries, Inc.
Timken Roller Bearing Co.

Bearings, Roller, Thrust
Timken Roller Bearing Co.

Belting, Rubber, Canvas
Russell Mfg. Co.

Belts, Fan
Gilmer Co., L. H.
Russell Mfg. Co.

Bindings
Carter Co., George R.

Blanks, Fibre Gear
Celoron Co.

Blanks, Gear
Akron-Selle Co.
Bethlehem Steel Co.
Central Steel Co.
Link-Belt Co.
Park Drop Forge Co.
Union Switch & Signal Co.
Wyman-Gordon Co.

Blanks, Sprocket
Akron-Selle Co.

Boards, Floor and Toe
Parish Mfg. Corporation

Bodies, Steel
Budd Mfg. Co., E. G.

Bolts
Bowen Products Corporation
Ferry Cap & Set Screw Co.
Shuler Axle Co., Inc.
Thompson Products, Inc.

Bolts, Stripper
Danly Machine Specialties, Inc.

Boxes, Tool, Metal
Globe Machine & Stamping Co.

Boxes, Tote, Steel
Cleveland Wire Spring Co.

Brackets, Fender
Parish Mfg. Corporation
Smith Corporation, A. O.

Brake-Bands
Bossert Corporation
Celoron Co.

Brake-Drums
Bethlehem Steel Co.
Bossert Corporation
Smith Corporation, A. O.

Brake-Hose Assemblies, Hydraulic
Hydraulic Brake Co.

Brake-Lining
Celoron Co.
Johns-Manville, Inc.
Russell Mfg. Co.

Brakes, Air
General Electric Co.

Brakes, Hydraulic
Hydraulic Brake Co.
Midland Steel Products Co.

Brakes, Mechanical
Bendix Brake Co.
Midland Steel Products Co.

Brass Alloys
Dole Valve Co.
Mueller Brass Co.
Scovill Mfg. Co.

Broaches
Threadwell Tool Co.

Broaching Presses, Hand
Threadwell Tool Co.

Brushes
National Carbon Co., Inc.

Buckram, Leather
Carter Co., George R.

Bulbs (See Lamps, Electric Incandescent)

Bumpers, Passenger Car
American Chain Co.
C. G. Spring & Bumper Co.

Bushings, Babbitt
Federal-Mogul Corporation

Bushings, Bronze
Dole Valve Co.
Federal-Mogul Corporation
Johnson Bronze Co.
Mueller Brass Co.

Bushings, Composition
Celoron Co.

Bushings, Steel
Danly Machine Specialties, Inc.
Thompson Products, Inc.

Cable, Insulated
Copper & Brass Research Association
General Electric Co.
Graybar Electric Co., Inc.
Kerite Insulated Wire & Cable Co., Inc.
Packard Electric Co.

Camshafts
Park Drop Forge Co.
Wyman-Gordon Co.

Caps, Hub
Bossert Corporation
Scovill Mfg. Co.

Caps, Radiator
Scovill Mfg. Co.
Splitdorf-Bethlehem Electrical Co.

Caps, Tank
Akron-Selle Co.
Scovill Mfg. Co.

Carbureter Controls, Automatic
Dole Valve Co.

Carbureters
Byrne, Kingston & Co.
Marvel Carbureter Co.
Tillotson Mfg. Co.

Cases, Storage Battery
Richardson Co.

Casings, Radiator
Bossert Corporation

Castings, Aluminum
Aluminum Co. of America
Bohn Aluminum & Brass Corporation
Scovill Mfg. Co.
Stewart Die-Casting Corporation

Castings, Babbitt Metal
Federal-Mogul Corporation
Stewart Die-Casting Corporation

Castings, Brass
Bohn Aluminum & Brass Corporation
Mueller Brass Co.
Scovill Mfg. Co.
Stewart Die-Casting Corporation

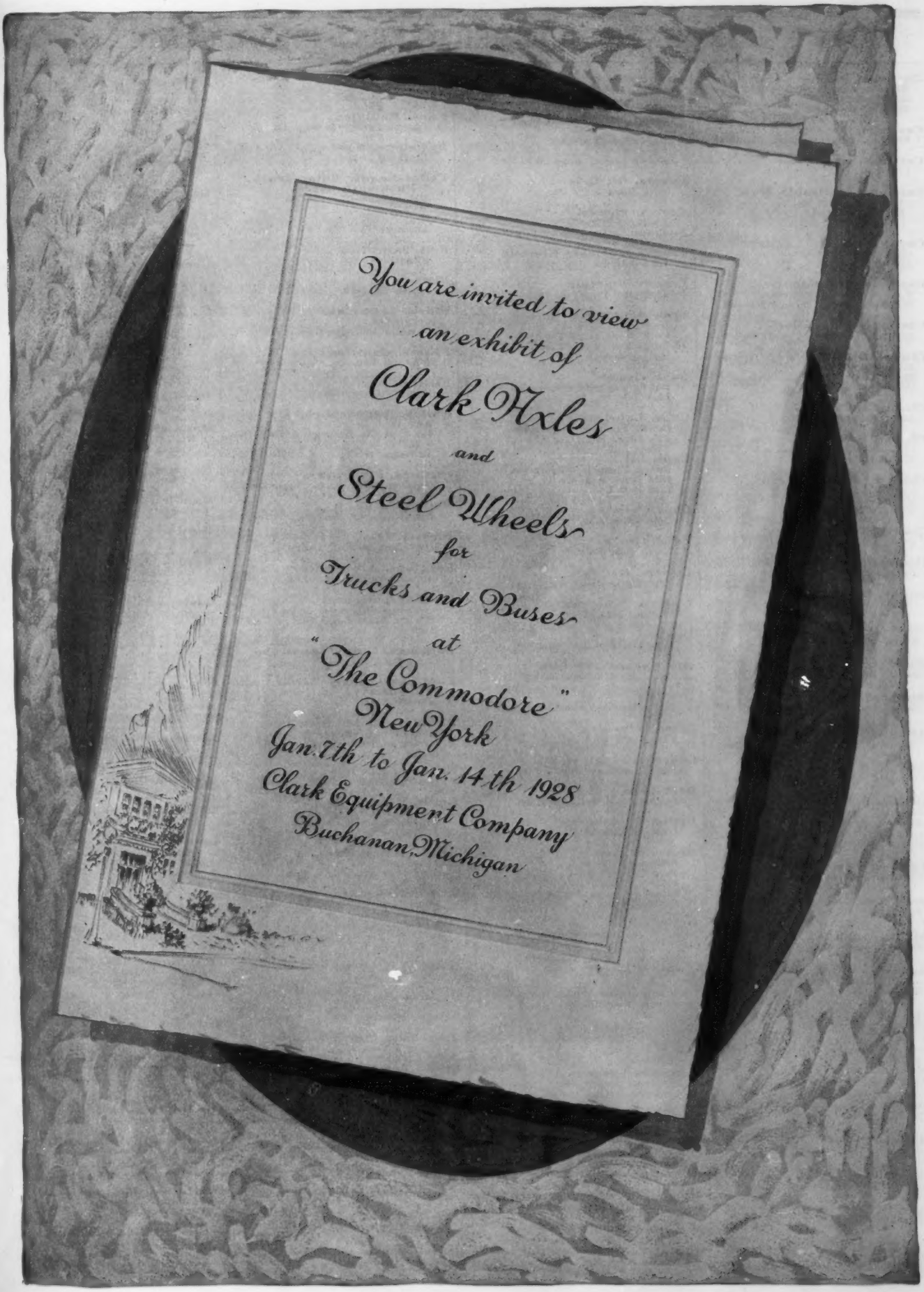
Castings, Bronze
Federal-Mogul Corporation
Johnson Bronze Co.
McGill Metal Co.
Mueller Brass Co.
Scovill Mfg. Co.
Stewart Die-Casting Corporation

(*Continued on page 124*)

Manufacturers of Products Conforming to S.A.E. Specifications

Advertisers whose products conform to S. A. E. specifications are also listed in the S. A. E. Handbook List of Manufacturers, on page 552, of the September, 1927, issue of the Handbook.

The addresses of companies listed in this index can be obtained from their current advertisements indexed on page 130.


You are invited to view
an exhibit of
Clark Axles
and
Steel Wheels
for
Trucks and Buses
at
"The Commodore"
New York
Jan. 7th to Jan. 14th 1928
Clark Equipment Company
Buchanan, Michigan

INDEX TO ADVERTISERS' PRODUCTS

(*Continued on page* 126)

Pipe joint engineering — not a profession but a function*

POWER PLANT engineers are becoming more favorable in their attitude toward oxwelded headers. They realize that in the present day installations, where higher pressures and much higher temperature are the governing factors, they must find a type of joint that will eliminate all possible hazard from leaks or breaks. The oxwelded joint is now offering these desirable and necessary characteristics.

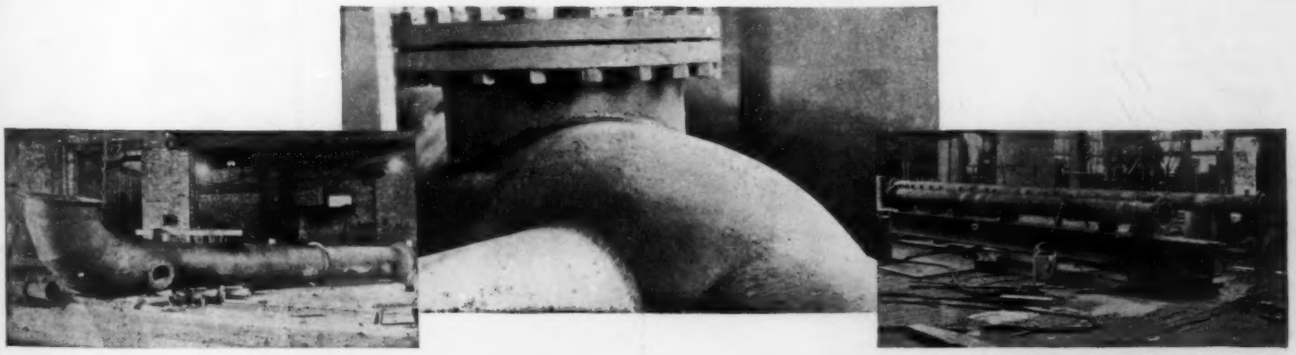
There are several obvious reasons for this. For instance, the first cost. Suppose we take as an example a ten-inch high-pressure header, thirty feet long, with six outlets varying from five to eight inches. With flanged joints and extra heavy cast steel fittings, such a header will cost approximately three times as much as a header having welded joints, welded outlets and a welded drip.

The maintenance of a joint is of still greater importance. Every engineer knows that flanged piping systems must be constantly tightened, that gaskets invariably develop leaks, and that expensive hand-moulded insulation must be replaced. The welded joint does not leak and requires no maintenance.

We have an interesting service report from an engineer in whose plant an oxwelded steam line has connected two main buildings for many years, who did not know that the line had oxwelded joints. It was installed sixteen years ago, before he took charge of the power plant, and in the intervening time has required no maintenance.

Since welded headers are proving so satisfactory, it is only logical that welded joints should be adopted throughout the entire power plant. Detailed information on the use of the oxy-acetylene process of welding and cutting in power plant piping under Linde Procedure Controls is available at Linde offices.

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
UCC
General Offices: Carbide and Carbon Building
30 East 42d Street, New York
37 PLANTS . . . . . 105 WAREHOUSES



LINDE OXYGEN

★No. 12 of a series of advertisements on the engineering phases of oxy-acetylene welding and cutting. Send for the booklet entitled: "Engineering and Management Phases of Oxwelded Construction."

INDEX TO ADVERTISERS' PRODUCTS

Joints, Universal
Spicer Mfg. Corporation

Keys, Woodruff
Whitney Mfg. Co.

Keyway, Sets
Threadwell Tool Co.

Lacing, Hood and Radiator
Russell Mfg. Co.

Lacquer, Pyroxylin
Arco Co.
Egyptian Lacquer Mfg. Co.
Valentine & Co.

Lamps, Electric Incandescent
General Electric Co.
Graybar Electric Co., Inc.

Lamps, Mercury Vapor
Cooper Hewitt Electric Co.

Lamps (See Head-Lamps)

Lathes, Chucking
Bullard Machine Tool Co.

Lathes, Turret
Bullard Machine Tool Co.

Leather
Carter Co., George R.

Linings, Battery Box
Celoron Co.

Linings, Transmission
Johns-Manville, Inc.

Links, Drag
Thompson Products, Inc.

Lubricants (See Oils, Lubricating)

Lubricating Systems
Bassick Mfg. Co.
Bijur Lubricating Corporation
Bowen Products Corporation

Lubrication, Automatic
Bowen Products Corporation
Madison-Kipp Corporation

Lubricators, Cylinder
Madison-Kipp Corporation

Lubricators, Wick Feed
Gits Bros. Mfg. Co.

Machines, Automatic Chucking
Bullard Machine Tool Co.

Machines, Automatic Multiple Spindle
Bullard Machine Tool Co.

Machines, Balancing
Olsen Testing Machine Co., Tinius

Machines, Boring (Vertical)
Bullard Machine Tool Co.

Machines, Boring, Turning and Facing (Vertical)
Bullard Machine Tool Co.

Machines, Chucking
Bullard Machine Tool Co.

Machines, Chucking and Turning
Bullard Machine Tool Co.

Machines, Milling
Whitney Mfg. Co.

Machines, Multiple Spindle
Bullard Machine Tool Co.

Machines, Power Transmission
Link-Belt Co.

Machines, Screw (See Screw Machines)

Machines, Testing
Olsen Testing Machine Co., Tinius

Machines, Turret Automatic
Bullard Machine Tool Co.

Magneto-Generators
Eisemann Magneto Corporation

Magnetos (Standard Mountings)
Eisemann Magneto Corporation

Manifolds, Wire
Celoron Co.

Material, Anti-Squeak
Gilmer Co., L. H.

Metal, Monel
International Nickel Co.

Mills, Vertical Boring and Turning
Bullard Machine Tool Co.

Moldings, Cold-Drawn Steel
Dahlstrom Metallic Door Co.

Moldings, Wire On
Carter Co., George R.

Moldings, Wood
Overton Co., S. E.

Molybdenum, Metallic
Vanadium Corporation of America

Motors (See Engines)

Motors, Starting (See Starting-Motors)

Nails
American Steel & Wire Co.
Interstate Iron & Steel Co.
Jones & Laughlin Steel Corporation
Wheeling Steel Corporation

Nickel
International Nickel Co.

Nitrogen
Linde Air Products Co.

Nuts
Ferry Cap & Set Screw Co.
Shuler Axle Co., Inc.

Nuts, Thumb
Eberhard Mfg. Co.

Odometers, Hub
Johns-Manville, Inc.

Oil-Pumps
Byrne, Kingston & Co.

Oilers, Mechanical
Bowen Products Corporation
Madison-Kipp Corporation

Oiling Systems
Bowen Products Corporation
Madison-Kipp Corporation

Ovens, Electric
General Electric Co.

Oxygen
Linde Air Products Co.

Packing, Abestos and Fibrous
Johns-Manville, Inc.

Packings
Celoron Co.

Paints, (See also Varnish, Enamel, etc.)
Arco Co.

Panels, Instrument
Dahlstrom Metallic Door Co.
Scovill Mfg. Co.

Panels, Wood Wainscoting
Overton Co., S. E.

Parts, Pressed Steel (See Stampings)

Pedestal, Seat
Eberhard Mfg. Co.

Pencils, Drawing
American Lead Pencil Co.

Pinions
Celoron Co.
General Electric Co.

Pinions, Starting-Motor
Electric Auto-Lite Co.

Pins, Cotter
American Chain Co.
Shuler Axle Co., Inc.

Pins, King
Thompson Products, Inc.

Pins, Leader
Danly Machine Specialties, Inc.

Pins, Piston
Thompson Products, Inc.

Pins, Steel Dowel
Danly Machine Specialties, Inc.

Pipe Fittings
Dole Valve Co.
Mueller Brass Co.
Titeflex Metal Hose Co.

Pipes (See Tubing, Flexible Metal)

Pistons, Aluminum
Aluminum Co. of America
Bohn Aluminum & Brass Corporation

Piston-Rings
Piston Ring Co.

Plates, Tin and Terne (See Steel, Sheet)

Pliers
Crescent Tool Co.

Powder, Aluminum Paint
Aluminum Co. of America

Powerplants, Industrial
Waukesha Motor Co.

Power Take-Offs
Fuller & Sons Mfg. Co.

Presses, Arbor
Threadwell Tool Co.

Presses, Bronching
Threadwell Tool Co.

Primers
Arco Co.
Dole Valve Co.

Propeller-Shafts
Salisbury Axle Co.
Spicer Mfg. Corporation

Pyroscopes
Shore Instrument & Mfg. Co.

Radiators
G & O Mfg. Co.
Long Mfg. Co.
Modine Mfg. Co.

Rails, Robe
Carter Co., George R.

Reamers
Clark Equipment Co.
Threadwell Tool Co.

Reamers, Burring
Threadwell Tool Co.

Reamers, Pipe
Threadwell Tool Co.

Reamers, Taper Pin Hole
Threadwell Tool Co.

Regulators, Temperature
Dole Valve Co.
Fulton Syphon Co.

Regulators, Window
Ternstedt Mfg. Co.

Relays, Cut-Out
North East Electric Co.

Removers, Screw
Threadwell Tool Co.

Retainers, Ball
Aetna Ball Bearing Mfg. Co.
Bearings Co. of America
Bossert Corporation

Ribbons, Fender
Dahlstrom Metallic Door Co.

Rims, Pneumatic Tire
Bethlehem Steel Co.
Motor Wheel Corporation

Rims, Solid—Rubber Tires
Bethlehem Steel Co.

Rings, Timer
Celoron Co.

Rings, Welded Steel
Akron-Selle Co.

Rivets, Brass and Copper
Scovill Mfg. Co.

Rivets, Steel
Interstate Iron & Steel Co.

Rod, Aluminum
Aluminum Co. of America

Rod, Brake
Thompson Products, Inc.

Rod, Brass
Mueller Brass Co.
Scovill Mfg. Co.

Rod, Bronze
Mueller Brass Co.
Scovill Mfg. Co.

Rod-Ends
Eberhardt Mfg. Co.
National Lock Washer Co.
Thompson Products, Inc.

Rod, Fibre
Celoron Co.
National Vulcanized Fibre Co.

Rod, Free-Cutting Brass
Copper & Brass Research Association
Mueller Brass Co.
Scovill Mfg. Co.

Rod, Naval Brass
Copper & Brass Research Association
Mueller Brass Co.
Scovill Mfg. Co.

Rod, Tie
Thompson Products, Inc.

Rod, Torque
Thompson Products, Inc.

Roller Bearings (See Bearings, Roller)

Running-Boards
Parish Mfg. Corporation
Smith Corporation, A. O.

Scleroscopes
Shore Instrument & Mfg. Co.

Screw Drivers
Crescent Tool Co.

Screw-Machine Products
Akron-Selle Co.
Aluminum Co. of America
Barnes Co., Wallace
Commonwealth Brass Corporation
Dole Valve Co.
Ferry Cap & Set Screw Co.
Link-Belt Co.
Mueller Brass Co.
New Process Gear Co., Inc.
Scovill Mfg. Co.
Spicer Mfg. Corporation

Screw Plates
Threadwell Tool Co.

Screws, Cap
Ferry Cap & Set Screw Co.
Mechanics Machine Co.
Scovill Mfg. Co.
Shuler Axle Co., Inc.

Screws, Machine
Scovill Mfg. Co.

Screws, Set
Ferry Cap & Set Screw Co.

Screws, Thumb
Eberhard Mfg. Co.

Screws, Wood
Interstate Iron & Steel Co.

Seats, Auxiliary
Eberhard Mfg. Co.

Sets, Die
Danly Machine Specialties, Inc.

Shafts, Rear Axle
Salisbury Axle Co.

Shafts, Propeller
Spicer Mfg. Corporation

Shapes (Extruded Brass and Bronze)
Mueller Brass Co.
Scovill Mfg. Co.

Sheets, Aluminum
Aluminum Co. of America

Sheets, Brass
Copper & Brass Research Association
Scovill Mfg. Co.

Sheets, Copper
Copper & Brass Research Association

Sheets, Fiber
Celoron Co.
National Vulcanized Fibre Co.

Sheets, Steel (See Steel, Sheet)

Shelving, Steel
Cleveland Wire Spring Co.

(Continued on page 128)

INDEX TO ADVERTISERS' PRODUCTS

Shims, Laminated
Laminated Shim Co., Inc.

Shock Insulator, Rubber
American Chain Co.

Shoes, Brake
Bossert Corporation
Celoron Co.

Shutters, Radiator, Hand Controlled
Globe Machine & Stamping Co.

Sills, Body
Smith Corporation, A. O.

Speedometers
North East Electric Co.

Spokes, Wood, Motor Truck
Motor Wheel Corporation

Spokes, Wood, Passenger Car
Motor Wheel Corporation

Springs, Air
American Steel & Wire Co.

Springs, Coiled
American Steel & Wire Co.
Barnes-Gibson-Raymond, Inc.
Cleveland Wire Spring Co.
Danly Machine Specialties, Inc.
Dole Valve Co.
Gibson Co., Wm. D.

Springs, Flat
American Steel & Wire Co.
Barnes Co., Wallace
Barnes-Gibson-Raymond, Inc.
Cleveland Wire Spring Co.
Gibson Co., Wm. D.

Springs, Leaf
Standard Steel Spring Co.

Sprockets, Block-Chain
Whitney Mfg. Co.

Sprockets, Roller-Chain
Link-Belt Co.
Whitney Mfg. Co.

Sprockets, Silent-Chain
Link-Belt Co.
Morse Chain Co.
Whitney Mfg. Co.

Stampings
Akron-Selle Co.
Barnes Co., Wallace
Bossert Corporation
Bowen Products Corporation
Globe Machine & Stamping Co.
Midland Steel Products Co.
Motor Wheel Corporation
Parish Mfg. Corporation
Scovill Mfg. Co.
Smith Corporation, A. O.
Spicer Mfg. Corporation
Stanley Works

Starter-Generators
North East Electric Co.

Starting-Motors (Standard Mountings)
Electric Auto-Lite Co.
Leece-Neville Co.
North East Electric Co.

Steel, Alloy
Bethlehem Steel Co.
Central Alloy Steel Corporation
Donner Steel Co., Inc.
Illinois Steel Co.
Interstate Iron & Steel Co.
Shuler Axle Co., Inc.
Union Drawn Steel Co.

Steel, Carbon
Barnes Co., Wallace
Bethlehem Steel Co.
Central Alloy Steel Corporation
Donner Steel Co., Inc.
Illinois Steel Co.
Interstate Iron & Steel Co.
Jones & Laughlin Steel Corporation
Shuler Axle Co., Inc.
Union Drawn Steel Co.

Steel, Cold Drawn
American Steel & Wire Co.
Jones & Laughlin Steel Corporation

Steel, Leaf Spring
Central Alloy Steel Corporation

Steel, Molybdenum
Central Alloy Steel Corporation

Steel, Non-Corrosive
Bethlehem Steel Co.

Steel, Rivet
Bethlehem Steel Co.
Illinois Steel Co.
Interstate Iron & Steel Co.
Jones & Laughlin Steel Corporation

Steel, Screw Stock
Jones & Laughlin Steel Corporation

Steel, Sheet and Plate
American Sheet & Tin Plate Co.
Jones & Laughlin Steel Corporation
Wheeling Steel Corporation

Steel, Tool
Bethlehem Steel Co.

Steel Wire
Jones & Laughlin Steel Corporation
Wheeling Steel Corporation

Stock, Steel (See Steel, Sheet)

Stocks, Die
Threadwell Tool Co.

Straps, Door-Stop
Carter Co., George R.

Straps, Luggage
Gilmer Co., L. H.

Straps, Tire and Truck
Russell Mfg. Co.

Straps, Top
Russell Mfg. Co.

Strip, Phosphor Bronze
Copper & Brass Research Association

Studs, Ball
Thompson Products, Inc.

Superheat System, Gasoline
Deppe Motors Corporation

Supplies, Die Makers'
Danly Machine Specialties, Inc.

Surfacers
Egyptian Lacquer Co.
Valentine & Co.

Switches, Starting
Electric Auto-Lite Co.
Leece-Neville Co.
North East Electric Co.

Sylphon, Automobile
Fulton Sylphon Co.

Systems, Fuel-Supply
Byrne, Kingston & Co.

Systems, Lubrication (See Lubricating Systems)

Systems, Oiling (See Oiling Systems)

Systems, Oiling, Central
Bowen Products Corporation

Tachometers (with Standard Drive)
Johns-Manville, Inc.

Tacks
American Steel & Wire Co.
Interstate Iron & Steel Co.

Tanks, Vacuum
Byrne, Kingston & Co.

Tape, Friction
Firestone Tire & Rubber Co.
Graybar Electric Co., Inc.

Tape, Insulated
Graybar Electric Co.
Kerite Insulated Wire & Cable Co.
Johns-Manville, Inc.

Tappets
Thompson Products, Inc.

Tappets, Push-Rod
Celoron Co.

Taps
Threadwell Tool Co.

Taps, Ground Thread
Threadwell Tool Co.

Taps, Special
Threadwell Tool Co.

Testers, Hardness
Shore Instrument & Mfg. Co.

Thermometers, Distance-Type
Moto Meter Co., Inc.

Thermometers, Radiator-Type
Moto Meter Co., Inc.

Thermostats
Bishop & Babcock Sales Co.
Dole Valve Co.
Fulton Sylphon Co.

Timer-Distributors
Electric Auto-Lite Co.
North East Electric Co.

Tire Carriers
Detroit Carrier & Mfg. Co.

Tire Locks
Detroit Carrier & Mfg. Co.

Tire Pumps, Hand, Self Oiling
Monroe Auto Equipment Co.

Tire-Pumps, Transmission Type
Detroit Carrier & Mfg. Co.

Tires, Industrial Truck
Firestone Tire & Rubber Co.

Tires, Motorcycle
Firestone Tire & Rubber Co.

Tires, Pneumatic
Clark Equipment Co.
Firestone Tire & Rubber Co.
United States Rubber Co.

Tires, Solid
Clark Equipment Co.
Firestone Tire & Rubber Co.
United States Rubber Co.

Tools, Forged Lathe
Bullard Machine Tool Co.

Tools, Special
Threadwell Tool Co.

Torque-Arms
Bossert Corporation
Smith Corporation, A. O.

Torsion-Rod Assemblies
Thompson Products, Inc.

Transmissions
Fuller & Sons Mfg. Co.
Mechanics Machine Co.
Warner Corporation

Tubes, Fibre
Celoron Co.
National Vulcanized Fibre Co.

Tubing, Aluminum
Aluminum Co. of America

Tubing, Brass
Copper & Brass Research Association
Mueller Brass Co.
Scovill Mfg. Co.

Tubing, Copper
Copper & Brass Research Association
Mueller Brass Co.
Scovill Mfg. Co.

Tubing, Flexible Metal
Copper & Brass Research Association
Titeflex Metal Hose Co.

Tubing, Naval Brass
Copper & Brass Research Association
Scovill Mfg. Co.

Tubing, Steel
Smith Corporation, A. O.

Tubing, Windshield
Dahlstrom Metallic Door Co.

Tungsten, Metallic
Arco Co.
Vanadium Corporation of America

Turret Machines, Vertical
Bullard Machine Tool Co.

Universal-Joints
Mechanics Machine Co.
Spicer Mfg. Corporation

Valves, Gasoline Needle
Commonwealth Brass Corporation
Dole Valve Co.

Valves, Poppet
Schlieder Mfg. Co.
Thompson Products, Inc.
Toledo Steel Products Co.

Valves, Shut-Off
Dole Valve Co.

Valves, Thermostatic Water Control
Dole Valve Co.

Valves, Tire
Schrader's Son, Inc., A.

Varnishes, Color
Valentine & Co.

Varnishes, Finishing
Arco Co.
Valentine & Co.

Varnishes, Rubbing
Arco Co.
Valentine & Co.

Washers
Bossert Corporation
Celoron Co.

Washers, Composition
Celoron Co.

Washers, Hardened and Ground
Aetna Ball Bearing Mfg. Co.

Washers, Lock
National Lock Washer Co.
Shuler Axle Co., Inc.

Washers, Plain
Copper & Brass Research Association
Interstate Iron & Steel Co.

Washers, Spring
Barnes Co., Wallace

Water-Temperature Controls Automatic
Dole Valve Co.

Webbing, Anti-Squeak
Russell Mfg. Co.

Webbing, Top
Russell Mfg. Co.

Welding Equipment
Bossert Corporation

Welding Rod, Bronze
Mueller Brass Co.
Scovill Mfg. Co.

Wheels, Dual Pneumatic, with Hub Integral
Hoopes, Bro. & Darlington, Inc.

Wheels, Metal
Budd Wheel Co.
Clark Equipment Co.
Dayton Steel Foundry Co.
Hoopes, Bro. & Darlington, Inc.
Smith Corporation, A. O.

Wheels, Pressed Steel Disc
Budd Wheel Co.
Clark Equipment Co.
Motor Wheel Corporation

Wheels, Trailer
Hoopes, Bro. & Darlington, Inc.

Wheels, Truck Rolled Steel
Bethlehem Steel Co.

Wheels, Truck Steel
Dayton Steel Foundry Co.

Wheels, Wire
Budd Wheel Co.

Wheels, Wood
Hoopes, Bro. & Darlington, Inc.
Motor Wheel Corporation

Wheels, Wood-Spokes, Metal Felloes
Hoopes, Bro. & Darlington, Inc.

Wicks, Felt
American Felt Co.

Wire (See Cable, Insulated)

Wire, Aluminum
Aluminum Co. of America

Wire Forms
Barnes Co., Wallace
Cleveland Wire Spring Co.

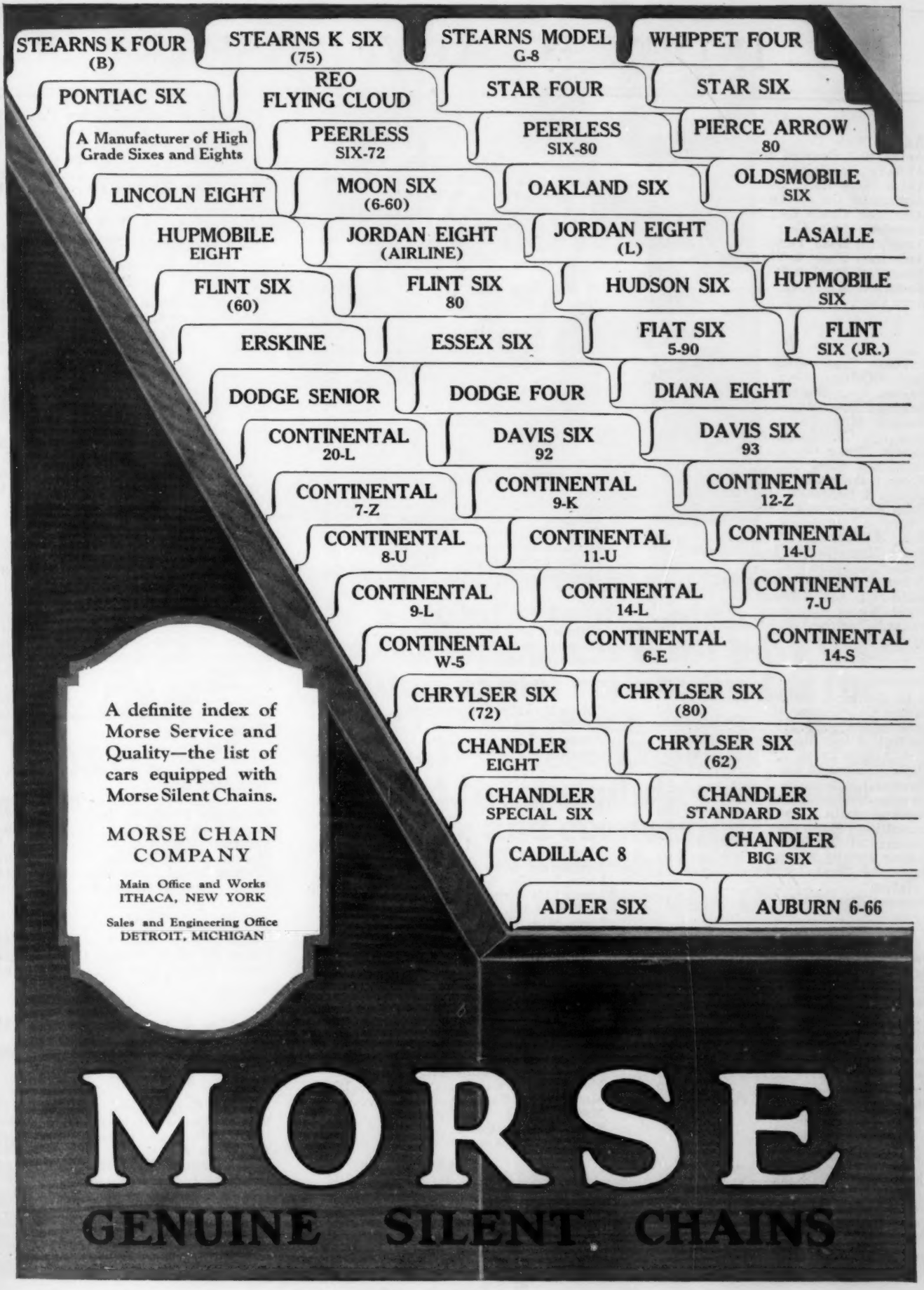
Wire Products
American Steel & Wire Co.
Barnes Co., Wallace
Interstate Iron & Steel Co.
Jones & Laughlin Steel Corporation

Wire, Steel (See Steel Wire)

Wrenches
Crescent Tool Co.

Wrenches, Socket
Splitdorf-Bethlehem Electrial Co.

Wrenches, Tap, Adjustable
Threadwell Tool Co.


STEARNS K FOUR (B)
STEARNS K SIX (75)
STEARNS MODEL G-8
WHIPPET FOUR
PONTIAC SIX
REO FLYING CLOUD
STAR FOUR
STAR SIX
A Manufacturer of High Grade Sixes and Eights
PEERLESS SIX-72
PEERLESS SIX-80
PIERCE ARROW 80
LINCOLN EIGHT
MOON SIX (6-60)
OAKLAND SIX
OLDSMOBILE SIX
HUPMOBILE EIGHT
JORDAN EIGHT (AIRLINE)
JORDAN EIGHT (L)
LASALLE
FLINT SIX (60)
FLINT SIX 80
HUDSON SIX
HUPMOBILE SIX
ERSKINE
ESSEX SIX
FIAT SIX 5-90
FLINT SIX (JR.)
DODGE SENIOR
DODGE FOUR
DIANA EIGHT
CONTINENTAL 20-L
DAVIS SIX 92
DAVIS SIX 93
CONTINENTAL 7-Z
CONTINENTAL 9-K
CONTINENTAL 12-Z
CONTINENTAL 8-U
CONTINENTAL 11-U
CONTINENTAL 14-U
CONTINENTAL 9-L
CONTINENTAL 14-L
CONTINENTAL 7-U
CONTINENTAL W-5
CONTINENTAL 6-E
CONTINENTAL 14-S
CHRYLSER SIX (72)
CHRYLSER SIX (80)
CHANDLER EIGHT
CHRYLSER SIX (62)
CHANDLER SPECIAL SIX
CHANDLER STANDARD SIX
CADILLAC 8
CHANDLER BIG SIX
ADLER SIX
AUBURN 6-66
A definite index of Morse Service and Quality—the list of cars equipped with Morse Silent Chains.
MORSE CHAIN COMPANY
Main Office and Works
ITHACA, NEW YORK
Sales and Engineering Office
DETROIT, MICHIGAN
MORSE
GENUINE SILENT CHAINS

INDEX TO ADVERTISERS

The Index to Advertisers' Products is given on pages 122, 124, 126, and 128


TERNSTEDT
Designers and Makers
DETROIT
U. S. A.

Here is the big idea:

The thing that is uncomfortable in motoring is excessive force of spring rebound. Excessive rebound force is the thing that throws us up and off the seat. The greater the excess of this force, the greater becomes the throw.

Other devices deal with these throws. In different manners and by different means and in different degrees they attempt to stop the throws.

Watson Stabilators do not attempt to do anything of that sort. The Watson thought has always been that it would be better to prevent these throws than to attempt to stop them **after they have become throws.**

To do this has by no means been an easy matter. We finally accomplished our desire, however—and very simply.

Watson Stabilators simply **use up** a certain amount of the rebound force. They start using up this excess force before the excess force can act against the car body and passengers. The instant the force starts to move the axle and frame apart, it finds that it has four Watson Stabilators to drag as well as the car body to lift. Dragging the Stabilators uses up the excess force, and hence the force which remains in the springs to raise the car body is not sufficient to throw the body—merely sufficient to raise it, nicely, gently.

Watson Stabilators have again proved to the world that old, old truth, that it is better to **prevent** something than to try to stop it after it has happened.

Original and Sole Manufacturers of Stabilation

JOHN WARREN WATSON COMPANY

Philadelphia

(Detroit Branch: 3081-3083 Grand Boulevard, East)

WATSON STABILATORS

Use up the Force which would Otherwise Throw You